THE UNIVERSITY OF ALBERTA

TAXONOMY AND ECOLOGY OF HELMINTHS OF GREBES IN ALBERTA.

by

JOHN RICHARD GALLIMORE

A THESIS

SUBMITTED TO THE FACULTY OF GRADUATE STUDIES

IN PARTIAL FULFILMENT OF THE REQUIREMENTS FOR THE DEGREE

OF MASTER OF SCIENCE

DEPARTMENT OF ZOOLOGY

EDMONTON, ALBERTA

OCTOBER, 1964

UNIVERSITY OF ALBERTA

FACULTY OF GRADUATE STUDIES

The undersigned certify that they have read, and recommend to the Faculty of Graduate Studies for acceptance, a thesis entitled Taxonomy and Ecology of Helminths of Grebes in Alberta submitted by John Richard Gallimore in partial fulfilment of the requirements for the degree of Master of Science.

ABSTRACT

A survey of the helminths of five species of grebes was conducted in central and southern Alberta from June 1961 to April 1964.

Forty-seven species of helminths were found, including 17 species of trematodes, 19 species of cestodes (7 of which appear to be new), 9 species of nematodes, 1 species of acanthocephalan and 1 species of leech. Seventy-three new host and nine new North American records were recorded.

This study indicated that slight differences in the helminthofauna of different grebe species were due to specificity of the parasites. The main differences seem to be due to habitat and food. Grebes of the same species found in different habitats (ponds, sloughs, and lakes), eating different foods, were found to have a different helminthofauna. Modifying influences on the effects of food and habitat are the seasonal and age effects.

Extensity patterns of individual parasites were found with seasonal changes. Intensity of helminth infections varied also with season. The infections were light in the early spring, reached a peak about the end of May, followed by a remarkable drop during the incubation period with another increase about the end of July in Podiceps caspicus and P. auritus, but not in P. grisegena. A slight decline in infection was indicated before the adult birds left in late summer. The immature birds showed in the fall a gradual increase of intensity of infection.

One juvenile and one adult parasite were found. The immature birds were not more heavily infected than adults. The young of three grebe species were found to show different patterns of acquisition of helminths depending on the habitat. The most common helminths of grebes infected the young birds first.

ACKNOWLEDGEMENTS

I wish to express my thanks to Dr. J. C. Holmes, chairman of my committee, for his guidance, editorial assistance, and especially for his encouragement during the collection of data and the preparation of this manuscript.

I am grateful to Dr. D. Boag and Dr. G. E. Ball for their editorial assistance, Dr. J. E. Moore for identification of the leeches, and Dr. R. W. Storer for the collection of some parasites and taxonomic information on the grebes.

Financial aid was received from the National Research Council of Canada in the form of a bursary and studentship.

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

INTRODUCTION 1

MATERIALS AND METHODS 2

SYSTEMATICS OF THE PARASITES 12

Trematoda 12

Cestoda 37

Nematoda 75

Acanthocephala 100

Hirudinea 101

SPECIFICITY OF HELMINTHS OF GREBES 107

THE INFLUENCE OF SEASON ON THE HELMINTHOFAUNA OF GREBES 115

THE INFLUENCE OF HOST HABITAT ON THE HELMINTHOFAUNA OF GREBES 128

THE INFLUENCE OF AGE OF THE HOST ON ITS HELMINTHOFAUNA.. 134

THE INFLUENCE OF FEEDING HABITS OF THE HOST ON THE HELMINTHOFAUNA 145

SUMMARY 155

BIBLIOGRAPHY 157

PLATES 165

LIST OF TABLES

Table I — Collection localities........................ 3

Table II — Helminthofauna of four species of adult grebes in Alberta............................ 13

Table III — Helminthofauna of immature grebes of five species in Alberta........................... 15

Table IV — New host and North American records.......... 18

Table V — Incidence of *Apatemon gracilis* in four species of grebes in Alberta................. 23

Table VI — Incidence of *Petasiger nitidus* in five species of grebes in Alberta................. 28

Table VII — Incidence of *Eucotyle cohni* in *Podiceps auritus* in Alberta.......................... 33

Table VIII — Variation of *Maritrema japonicum* in *Histrionicus histrionicus pacificus* and in three species of grebes.............. 35

Table IX — Incidence of *Ligula intestinalis* in four species of grebes in Alberta........... 39

Table X — Incidence of *Schistocephalus solidus* in four species of grebes in Alberta........... 41

Table XI — Incidence of *Tetrabothrius immerinus* and *T*. sp. (immature) in two species of grebes in Alberta.................................... 44

Table XII — Incidence of *Dicranotaenia* sp. in *Aechmophorus occidentalis* in Alberta......... 47

Table XIII — A comparison of specimens of *Dicranotaenia pingi* from *Anas segetum* and *Dicranotaenia* sp.

List of Tables (continued):

	from *Aechmophorus occidentalis*	48
Table XIV	Incidence of *Diorchis* sp. in *Podiceps caspicus* in Alberta	50
Table XV	Incidence of *Dubininolepis furcifera* in five species of grebes in Alberta	52
Table XVI	Size of rostellar hooks of *D. furcifera* from three species of grebes	54
Table XVII	Incidence of *Dubininolepis podicipina* in *Podiceps caspicus* in Alberta	56
Table XVIII	Incidence of *Hymenosphenacanthus* sp. 1 in *Podiceps caspicus* in Alberta	58
Table XIX	Incidence of *Parafimbriaria websteri* in three species of grebes in Alberta	62
Table XX	Incidence of *Schistotaenia colymba* in *Podiceps caspicus* and *P. auritus* in Alberta	64
Table XXI	Incidence of *Schistotaenia* sp. in three species of grebes in Alberta	66
Table XXII	Incidence of *Tatria biremis* in three species of grebes in Alberta	69
Table XXIII	Incidence of *Tatria decacantha* in three species of grebes in Alberta	72
Table XXIV	Incidence of *Dioecocestus fuhrmanni* in *Podiceps grisegena*	74
Table XXV	Incidence of *Capillaria michiganensis* in three species of grebes in Alberta	77
Table XXVI	Incidence of *Capillaria pachyderma* in three species of grebes in Alberta	80

List of Tables (continued)

Table XXVII Incidence of _Contracaecum podicipitis_ in three species of grebes in Alberta........ 83

Table XXVIII Incidence of _Contracaecum_ sp. (immature) in five species of grebes in Alberta......... 85

Table XXIX Incidence of infection of _Streptocara crassicauda_ in four species of grebes in Alberta.................................... 88

Table XXX Incidence of _Cosmocephalus firlottei_ in four species of grebes in Alberta......... 90

Table XXXI Incidence of _Echinuria decorata_ in four species of grebes in Alberta............ 93

Table XXXII Incidence of _Tropisurus fissispina_ in four species of grebes in Alberta............ 96

Table XXXIII Incidence of _Spirofilaria fulicae-atrae_ in three species of grebes in Alberta.. 98

Table XXXIV Incidence of _Polymorphus paradoxus_ in four species of grebes in Alberta............102

Table XXXV Incidence of _Theromyzon rude_ and _Theromyzon_ sp. in five species of grebes in Alberta....................................105

Table XXXVI Categorization of host-parasite relationships in five species of grebes in Alberta...110

Table XXXVII Structure of the helminthofauna of grebe habitats.......................................130

Table XXXVIII Occurrence of helminths in immature _Podiceps auritus_ examined from ponds and lakes........132

List of Tables (continued)

Table XXXIX Helminths restricted to adult or immature grebes.................................135

Table XL Percent of occurrence of food items in gizzards of five species of grebes...........146

LIST OF FIGURES

Fig. 1 Sample autopsy sheet.............................. 6

Fig. 2 *Dubininolepis furcifera* - hook.................... 54

Fig. 3 Seasonal variation in extensity of helminths in *Podiceps caspicus*, group 1.....................115

Fig. 4 Seasonal variation in extensity of helminths in *Podiceps caspicus*, group 2.....................116

Fig. 5 Seasonal variation in extensity of helminths in *Podiceps caspicus*, group 3.....................117

Fig. 6 Seasonal variation in extensity of helminths in *Podiceps caspicus*, group 4.....................118

Fig. 7 Total parasites vs. season in *Podiceps caspicus*......................................122

Fig. 8 Total parasites vs. season in *Podiceps auritus*....123

Fig. 9 Total parasites vs. season in *Podiceps grisegena*.....................................124

Fig. 10 Total parasites vs. season in ♂ and ♀ *Podiceps caspicus*......................................126

Fig. 11 Acquisition of helminths with weight (age) in *Podiceps caspicus* and *Podiceps auritus*...........137

Fig. 12 Acquisition of parasites with weight (age) in *Podiceps grisegena*...............................138

Fig. 13 Extensity vs. first occurrence of helminths in three species of grebes..........................140

Fig. 14 Relative infections of adult and immature grebes..141

Fig. 15 Relative infections of adult and immature grebes..142

List of Figures (continued)

Fig. 16 Seasonal variation of main food items of *Podiceps caspicus*....................................150

Fig. 17 Percent occurrence of main food items in 80 adult and 56 immature *Podiceps caspicus*...........151

Fig. 18 Percent occurrence of main food items in 42 adult and 33 immature *Podiceps auritus*............152

Fig. 19 Percent occurrence of main food items in 30 adult and 32 immature *Podiceps grisegena*..........153

INTRODUCTION

Five species of grebes are found in Alberta: Eared Grebe, *Podiceps caspicus* (Hablizl, 1783), Horned Grebe, *Podiceps auritus* (Linnaeus, 1758), Red-necked Grebe, *Podiceps grisegena* (Boddaert, 1783), Western Grebe, *Aechmophorus occidentalis* (Lawrence, 1858), and Pied-billed Grebe, *Podilymbus podiceps* (Linnaeus, 1758). A survey of the helminthofauna of these birds was the first object of this study. As differences in the parasitism of birds due to specificity of the parasites, habitat of the hosts, season, age, and food have been reported by other authors (Sulgostowska, 1958 and 1963; Bychovskaya-Pavlovskaya, 1962; Cornwell and Cowan, 1963; Bezubik, 1956; *inter alia*), it was hoped that the results obtained in this study would provide more insight into these host-parasite relationships. Therefore, samples of grebes were collected from different habitats, at predetermined intervals, and representing different age classes.

Specimens of all parasites found are deposited in the collections of the Department of Zoology, University of Alberta and of the author.

MATERIALS AND METHODS

A total of 348 specimens of the five species of grebes occurring in Alberta (166 Podiceps caspicus, 81 Podiceps auritus, 72 Podiceps grisegena, 24 Aechmophorus occidentalis, and 6 Podilymbus podiceps) were collected in the period July 1960 - April 1964. The locations from which the birds were collected are shown in Table I.

All birds, with the exception of one Podiceps caspicus, one P. auritus, six P. grisegena and two Aechmophorus occidentalis collected by Dr. R. W. Storer; one P. caspicus and one P. grisegena collected by M. Colbo; one P. caspicus, one P. auritus and one P. grisegena collected by D. Fillion; one P. auritus and one P. grisegena collected by M. Riske; and one Aechmophorus occidentalis collected by J. Kerekes, were collected by the author.

The grebes were all shot with the exception of six Aechmophorus occidentalis, one Podiceps auritus and one Podiceps grisegena which were drowned in gill nets and three downy Aechmophorus occidentalis which were caught by hand.

When a bird was killed, it was retrieved and tagged with the location and date. Then it was placed in a plastic bag in a cool place until it could be returned to the laboratory. Families were kept together insofar as possible.

Autopsy of the Grebes

At the laboratory each bird was weighed, autopsied immediately (within eight hours after collection) or deep frozen, sealed in a plastic bag to prevent desiccation.

Table I

Collection Localities

Area	*Podiceps caspicus*	*Podiceps auritus*	*Podiceps grisegena*	*Aechmophorus occidentalis*	*Podilymbus podiceps*
Cooking Lake	55				
Big Is. Lake	63	22	59		
Hastings Lake				1	
Joseph Lake	12	2		1	
Pigeon Lake	1			4	
MacGregor Lake	1				
CPR Reservoir[1]	19	1			
Lehto's Reservoir[2]		4			
Barrier Reservoir	1	1	1		
Wabamun Lake		1	4	16	
Moose Lake			1	2	
Wakamao Lake			3		
Innes Lake			1		
St. Cyr (Island) Lake			1		
Cottage Lake			1		

cont'd

Table I (cont'd)

Area	*Podiceps caspicus*	*Podiceps auritus*	*Podiceps grisegena*	*Aechmophorus occidentalis*	*Podilymbus podiceps*
Beaverhill Lake		3			
Hay Lakes Area[3]	14				
Potholes (Edmonton)		46			
Beaverpond (Gorge Creek)		1			
8 mi. E. Kavanagh			1		
1 1/2 mi. S. 8 mi. E. Bremner					4
Sandy Lake					2
Total	166	81	72	24	6

[1]Canadian Pacific Railway Reservoir: 6 miles North, 1 1/2 miles East of Coaldale, Alberta.

[2]Lehto's Reservoir: 13 miles north of Picture Butte, Alberta.

[3]Hay Lakes Area: 2 miles west, 1 1/2 miles south of Hay Lakes Town, Alberta.

Both fresh and frozen birds were satisfactory for autopsy. The birds which were still slightly frozen were the easiest to work with as the body fluids did not tend to obscure the organs. The condition of the parasites in frozen birds was generally good. The larger cestodes, nematodes and trematodes were relaxed and ready to fix. Some of the smaller cestodes such as Tatria biremis tended to break up and the smaller strigeids such as Apatemon gracilis were partially digested. These parasites were still identifiable by comparison with specimens in better condition. The major advantage of frozen parasites is that no time-consuming relaxation procedures are necessary prior to fixation. The cestodes, nematodes and trematodes may be placed directly into the fixative. In a study of this kind the slightly poorer condition of the parasites from frozen birds is far out-weighed by the time saved when working with a great number of autopsies.

However, fresh material is necessary for comparison with partially digested worms for identification. Therefore, at least a few birds from every collection were autopsied immediately.

Before the bird was opened, measurements (see the sample autopsy sheet, Fig. 1) were taken and the type of plumage and presence or absence of a brood patch were noted.

First, the nostrils were examined by cutting through the bill and tissue from the posterior edge of each nostril posteriad to under the eye, then through the bone between the two nostrils. The resultant flap of skin and bone was folded back and both nasal cavities were examined. The gape

Figure 1.

Sample Autopsy Sheet. No.

Host: Method of Capture:

Weight: Location:

Age: Date:

Sex: Autopsy Date:

Examiner:

Buccal Cavity:

Nasal Cavity:

Eyes:

Heart:

Coelome:

Esophagus:

Proventriculus:

Ventriculus:

Small Intestine and Rectum:

Caeca:

Cloaca:

Bursa:

Trachea:

Lungs and Air Sacs:

Liver:

Pancreas:

Kidneys:

cont'd

Figure 1 (cont'd)

Wing Length (from bend):

Wing Spread:

Total Length:

Tail Length:

Iris to Bill Tip:

Foot Length (from heel):

Longest toe:

Hallux Length:

Brood Patch:

Plumage:

Gizzard Contents:

was then enlarged by slitting backwards through the angle of the mouth and buccal cavity examined.

The eyeballs were removed after cutting the corners of the eyelids. Both the eye socket and the surface of the eyeball were examined. (This was done only in eleven birds, all taken toward the end of the study.)

It was found advisable to remove the skin with the feathers from the abdomen and breast so that contamination with feathers was kept to a minimum. This was done by first cutting the skin up the ventral side of the body from the cloaca to the neck then peeling back the skin to either side and removing it. At this time the muscles and fascia were superficially examined. The sternum and the muscles of the ventral body wall were cut to reveal the internal organs which were removed and examined separately.

The liver was removed to a glass dish, macerated with two pairs of forceps, and rinsed with water until the blood was removed. Then the dish was placed over a piece of black plastic (against which the parasites could be more easily seen) and examined macroscopically. Anything that looked like a parasite was examined further under a dissecting microscope. If the liver was large, as in the case of the larger grebes, it was sub-divided before being examined.

The gizzard was then removed by cutting through the junction with the proventriculus and through the pylorus. It was slit along one side and the contents were removed to a vial of AFA or 70% ethanol (preferred) for later examination. As the horny lining was peeled away from the muscular wall,

both the surface of the muscular wall and the gizzard lining were examined for parasites.

The small intestine was severed just above the caeca, removed to a glass dish, and slit open. The contents were washed out and the intestine scraped to remove any parasites attached to the wall. The contents were washed, allowed to settle and the supernatant decanted. This was repeated until the supernatant was relatively clear. The residue was then examined macroscopically against a dark background. The dish was moved and the residue washed back and forth. Because of the different relative weights of parasites and tissue debris the parasites tended to move slower, and in this manner were easily distinguished. If the volume of water was small enough so that the bottom of the dish was not completely covered when the dish was tilted, the parasites tended to collect at the meniscus (due to differential relative weights). Large numbers of parasites could be collected by this method. Any parasites found were rough sorted, each type counted, and removed to separate dishes. It was not found necessary to examine the residue microscopically, as after practice it was possible to pick out the smallest parasites. However, all suspicious objects were examined with a microscope.

The caeca were removed, split, and examined in the same way, as was the rectum. The cloaca and the bursa (if present) were split and washed to reveal any parasites.

The proventriculus, esophagus and trachea were treated next; each was split, washed, scraped and examined. Special care was taken with the proventriculus; it was held up to a

strong light (100 watt bulb at 6 inches) to check for female *Tropisurus* within the proventricular glands. In the strong light they appear as dark spots in the wall of the proventriculus. These were removed by cutting the wall close to the nematodes and squeezing them out.

The gonads and oviducts were measured, then the kidneys were removed, the collecting ducts split open to expose the trematodes sometimes hidden in them, then the rest of the kidneys were macerated. The lungs and pancreas were also macerated. The air sacs and coelom were examined as the other organs were removed. Finally, the leg joints were exposed and examined for filarid nematodes. The ankle (tarsal) joint was exposed by making a cut on the outer side of the leg. Then a probe or needle was used to explore among the tendons and between the tendons and the skin. The filarids were usually found in pockets of light yellow fluid, but on occasion were found in necrotic sacs.

Preparation of the Parasites

Living trematodes, from freshly killed grebes, were restrained by pressing them between two slides, then fixed in AFA (Cable, 1951). Dead trematodes, from frozen grebes, were transferred directly to AFA. They were examined in the fixatives or stained in Semichon's acetocarmine (Cable, 1951), cleared in xylene, and mounted in balsam. A few specimens were paraffin embedded, sectioned, stained with Ehrlich's haematoxylin and eosin, and mounted in DPX (British Drug Houses, England).

Cestodes obtained alive were relaxed in cold tap-water

for a few hours or overnight. The smaller relaxed cestodes and the dead cestodes from frozen birds were transferred directly to vials of AFA. The longer cestodes were stretched out in dishes and fixed in AFA. The cestodes were examined in the fixative or stained with Semichon's acetocarmine or Ehrlich's haematoxylin (Baker, 1960) and mounted like the trematodes. Some were sectioned and stained in the same manner as the trematodes.

Nematodes, if living (from freshly killed grebes), were fixed in hot AFA. The dead worms were placed in cold AFA. They were cleared in lactophenol or mounted in glycerine (Cable, 1951) and examined.

Acanthocephalans, living or dead, were placed directly in AFA. Some were stained in Semichon's acetocarmine and mounted like the trematodes (with only partial success), but most were examined in the fixative. The adult females were cut to expose the embryos for examination.

SYSTEMATICS OF THE PARASITES

Forty-seven species of helminths, comprising 17 species of trematodes, 19 species of cestodes, nine species of nematodes, one species of acanthocephalan and one species of leech, were recovered in this study. Data on the species recovered, and their extensity and intensity of infection in each species of grebe are presented in Table II (adults) and III (immatures). Table IV records new host and new geographical (North American) records.

The classification of Yamaguti is used (1958, 1959, 1961 and 1963) except when stated otherwise. The super-generic classification of the trematodes used is that of LaRue (1957).

Hosts, habitat, life cycle and distributional data listed immediately below the species name in the following accounts are from the literature and do not include material from the present study. Unless otherwise stated, references may be found in Yamaguti (1958, 1959, 1961 and 1963).

Trematoda

Order Strigeatoidea

Family Strigeidae

1. *Cotylurus erraticus* (Rudolphi, 1809) Szidat, 1928

   Type host: *Colymbus septentrionalis* (= *Gavia stellata*).
   Other recorded hosts: *G. arctica*, *G. immer* and members of the Laridae.
   Habitat: small intestine.
   Life cycle: unknown; other members of the genus have metacercariae in fish.
   Distribution: Europe, Western Siberia, Canada.

Table II

Helminthofauna of Four Species of Adult Grebes in Alberta **

Helminth	*Podiceps caspicus*		*Podiceps auritus*		*Podiceps grisegena*		*Aechmophorus occidentalis*	
	Int.*	Ext.+	Int.	Ext.	Int.	Ext.	Int.	Ext.
Trematoda								
Cotylurus erraticus	-	-	-	-	18	6	3	22
Cotylurus pileatus	-	-	-	-	-	-	-	-
Cotylurus platycephalus	-	-	31	2	-	-	-	-
Cotylurus sp.	-	-	2	2	-	-	2	14
Apatemon gracilis	21	19	4	4	35	41	175	11
Tylodelphys podicipina	-	-	-	-	75	8	-	-
Dendritobilharzia anatinarum	1	1	-	-	-	-	-	-
Echinostoma revolutum	1	1	6	14	10	3	-	-
Petasiger nitidus	42	5	30	14	57	41	-	-
Echinochasmus donaldsoni	-	-	35	2	-	-	-	-
Stephanoprora pseudoechinata	4	1	-	-	-	-	-	-
Ribeiroia thomasi	-	-	1	2	1	3	-	-
Notocotylus attenuatus	-	-	-	-	-	-	-	-
Eucotyle cohni	7	2	16	33	4	9	-	-
Maritrema japonicum	1	1	-	-	16	6	-	-
Plagiorchis maculosus	-	-	-	-	10	3	-	-
Galactosomum humbargari	-	-	-	-	1	3	-	-
Orchipedum tracheicola	5	14	5	2	9	15	-	-
Cestoda								
Ligula intestinalis	6	4	1	7	25	17	15	56
Schistocephalus solidus	1	1	1	2	2	11	1	11
Tetrabothrius immerinus	8	1	5	14	11	29	-	-
Lateriporus sp.	-	-	-	-	1	3	-	-
Lateriporus sp. (immature)	1	1	-	-	5	6	-	-
Dicranotaenia sp.	-	-	-	-	-	-	49	88
Diorchis sp.	?	26	-	-	100	3	-	-
Dubininolepis furcifera	?	77	112	95	113	85	98	43
Dubininolepis podicipina	?	48	-	-	-	-	-	-
Hymenosphenacanthus sp. #1	?	7	-	-	75	3	-	-

cont'd

Table II (cont'd)

Helminth	Podiceps caspicus		Podiceps auritus		Podiceps grisegena		Aechmophorus occidentalis	
	Int.*	Ext.+	Int.	Ext.	Int.	Ext.	Int.	Ext.
Hymenosphenacanthus sp. #2	-	-	-	-	25	3	-	-
Nadejdolepis sp.	-	-	-	-	25	6	25	13
Parafimbriaria websteri	12	19	9	5	2	17	-	-
Schistotaenia colymba	11	33	27	22	-	-	-	-
Schistotaenia sp.	2	4	7	30	11	71	-	-
Schistotaenia tenuicirrus	-	-	-	-	-	-	-	-
Tatria biremis	119	71	160	85	55	53	-	-
Tatria decacantha	60	42	23	9	18	31	-	-
Dioecocestus fuhrmanni	-	-	-	-	2	30	-	-
Nematoda								
Capillaria michiganensis	5	32	17	11	8	34	-	-
Capillaria pachyderma	4	12	7	9	1	3	-	-
Contracaecum podicipitis	5	29	3	24	9	43	-	-
Contracaecum sp. (immature)	4	13	2	11	12	11	5	14
Streptocara crassicauda	8	61	4	40	22	79	-	-
Cosmocephalus firlottei	2	14	1	7	4	32	1	33
Dispharynx sp. (immature)	2	2	-	-	-	-	-	-
Echinuria decorata	3	48	5	60	7	29	1	14
Tropisurus fissispinus	2	8	6	29	1	3	1	13
Spirofilaria fulicae-atrae°	6	19	15	8	44	40	-	-
Acanthocephala								
Polymorphus paradoxus	18	8	13	2	29	63	40	11
Hirudinea								
Theromyzon rude	1	12	1	18	4	20	11	29

* Average number of individual parasites per infected bird.

\+ Percent infected.

** No adult Podilymbus podiceps were examined.

° According to the International Code of Zoological Nomenclature, London, 1961, the revised spelling should be Spirofilaria fulicaeatrae.

Table III

Helminthofauna of Immature Grebes of Five Species in Alberta

Helminth	Podiceps caspicus Int.	Podiceps caspicus Ext.	Podiceps auritus Int.	Podiceps auritus Ext.	Podiceps grisegena Int.	Podiceps grisegena Ext.	Aechmophorus occidentalis Int.	Aechmophorus occidentalis Ext.	Podilymbus podiceps Int.	Podilymbus podiceps Ext.
Trematoda										
Cotylurus erraticus	-	-	45	3	-	-	-	-	-	-
Cotylurus pileatus	-	-	-	-	-	-	146	43	-	-
Cotylurus platycephalus	12	2	8	3	-	-	190	8	-	-
Cotylurus sp.	-	-	-	-	1	3	-	-	-	-
Apatemon gracilis	15	20	-	-	7	21	-	-	-	-
Tylodelphys podicipina	-	-	-	-	-	-	108	53	-	-
Dendritobilharzia anatinarum	-	-	-	-	-	-	-	-	-	-
Echinostoma revolutum	-	-	1	3	-	-	-	-	-	-
Petasiger nitidus	29	5	125	3	33	33	29	17	42	100
Echinochasmus donaldsoni	-	-	-	-	-	-	75	8	-	-
Stephanoprora pseudoechinata	-	-	-	-	-	-	-	-	-	-
Ribeiroia thomasi	-	-	9	14	3	6	50	8	50	33
Notocotylus attenuatus	-	-	2	3	3	3	-	-	-	-
Eucotyle cohni	-	-	25	3	-	-	-	-	-	-
Maritrema japonicum	-	-	-	-	-	-	-	-	-	-
Plagiorchis maculosus	-	-	-	-	-	-	-	-	1	17
Galactosomum humbargari	-	-	-	-	-	-	-	-	-	-
Orchipedum tracheicola	1	2	1	3	-	-	-	-	-	-
Cestoda										
Ligula intestinalis	4	8	3	3	-	-	19	40	-	-

cont'd

Table III (cont'd)

Helminth	Podiceps caspicus		Podiceps auritus		Podiceps grisegena		Aechmophorus occidentalis		Podilymbus podiceps	
	Int.	Ext.	Int.	Ext.	Int.	Ext.	Int.	Ext.	Int.	Ext.
Schistocephalus solidus	6	10	1	8	5	18	35	7	-	-
Tetrabothrius immerinus	-	-	-	-	-	-	-	-	-	-
Lateriporus sp.	-	-	-	-	-	-	-	-	-	-
Lateriporus sp. (immature)	1	2	-	-	1	3	-	-	-	-
Dicranotaenia sp.	-	-	-	-	-	-	3	17	-	-
Diorchis sp.	?	38	-	-	-	-	-	-	-	-
Dubininolepis furcifera	?	67	83	57	59	49	287	36	2	17
Dubininolepis podicipina	?	5	-	-	-	-	-	-	-	-
Hymenosphenacanthus sp.#1	?	9	-	-	-	-	-	-	-	-
Hymenosphenacanthus sp. #2	-	-	-	-	-	-	-	-	-	-
Nadejdolepis sp.	-	-	-	-	-	-	-	-	-	-
Parafimbriaria websteri	12	11	4	3	-	-	-	-	-	-
Schistotaenia colymba	4	13	23	16	-	-	-	-	-	-
Schistotaenia tenuicirrus	-	-	-	-	-	-	-	-	2	17
Schistotaenia sp.	1	2	17	17	9	15	-	-	-	-
Tatria biremis	224	84	184	57	30	12	-	-	-	-
Tatria decacantha	69	16	55	6	5	3	-	-	-	-
Dioecocestus fuhrmanni	-	-	-	-	2	15	-	-	-	-
Nematoda										
Capillaria michiganensis	2	5	-	-	7	6	-	-	-	-
Capillaria pachyderma	-	-	-	-	-	-	-	-	-	-

cont'd

Table III (cont'd)

Helminth	Podiceps caspicus		Podiceps auritus		Podiceps grisegena		Aechmophorus occidentalis		Podilymbus podiceps	
	Int.	Ext.	Int.	Ext.	Int.	Ext.	Int.	Ext.	Int.	Ext.
Contracaecum podicipitis	5	31	2	14	6	9	-	-	-	-
Contracaecum sp. (immature)	13	9	2	6	15	11	39	8	1	17
Streptocara crassicauda	12	81	9	51	20	66	1	15	-	-
Cosmocephalus firlottei	6	36	2	11	3	24	2	15	-	-
Dispharynx sp. (immature)	-	-	-	-	-	-	-	-	-	-
Echinuria decorata	5	20	-	-	-	-	-	-	-	-
Tropisurus fissispinus	-	-	8	3	-	-	-	-	-	-
Spirofilaria fulicae-atrae	-	-	-	-	-	-	-	-	-	-
Acanthocephala										
Polymorphus paradoxus	10	6	1	3	5	6	-	-	-	-
Hirudinea										
Theromyzon rude	4	11	1	3	1	13	-	-	2	33

Table IV

New Host and North American Records.

Helminth	*Podiceps caspicus*	*Podiceps auritus*	*Podiceps grisegena*	*Aechmophorus occidentalis*	*Podilymbus podiceps*
Trematoda					
Cotylurus erraticus	-	1	1	1	-
Cotylurus pileatus	-	-	-	1,2	-
Cotylurus platycephalus	1	1	-	1	-
Cotylurus sp.	-	?	?	?	-
Apatemon gracilis	1	1	1	1	-
Tylodelphys podicipina	-	-	2	1,2	-
Dendritobilharzia anatinarum	1	-	-	-	-
Echinostoma revolutum	0	0	0	-	-
Petasiger nitidus	1	0	1	1	1
Echinochasmus donaldsoni	-	1	-	1	-
Stephanoprora pseudoechinata	1	-	-	-	-
Ribeiroia thomasi	-	1	1	1	1
Notocotylus attenuatus	-	1	1	-	-
Eucotyle cohni	0	1,2	0	-	-
Maritrema japonicum	1,2	-	1,2	-	-
Plagiorchis maculosus	-	-	1,2	-	1,2
Galactosomum humbargari	-	-	1	-	-
Orchipedum tracheicola	1	1	1	-	-
Cestoda					
Ligula intestinalis	0	0	0	0	-
Schistocephalus solidus	0	0	0	0	-
Tetrabothrius immerinus	-	0	0	-	-
Lateriporus sp.	-	-	NS?	-	-
Lateriporus sp. (immature)	?	-	?	-	-
Dicranotaenia sp.	-	-	-	1,2	-
Diorchis sp.	NS	-	NS	-	-
Dubininolepis furcifera	0	0	0	0	0
Dubininolepis podicipina	2	-	-	-	-
Hymenosphenacanthus sp. #1	NS	-	NS	-	-
Hymenosphenacanthus sp. #2	-	-	NS	-	-
Nadejdolepis sp.	-	-	NS?	NS?	-
Parafimbriaria websteri	0	1	1	-	-
Schistotaenia colymba	1	0	-	-	-
Schistotaenia sp.	NS	NS	NS	-	-
Schistotaenia tenuicirrus	-	-	-	-	0
Tatria biremis	0	0	0	-	-

cont'd

Table IV (cont'd)

Helminth	Podiceps caspicus	Podiceps auritus	Podiceps grisegena	Aechmophorus occidentalis	Podilymbus podiceps
Tatria decacantha	0	0	1	-	-
Dioecocestus fuhrmanni	-	-	0	-	-
Nematoda					
Capillaria michiganensis	1	1	1	-	-
Capillaria pachyderma	1	0	1	-	-
Contracaecum podicipitis	1	1	1	-	-
Contracaecum sp. (immature)	?	?	?	?	?
Streptocara crassicauda	2	1, 2	1, 2	1, 2	-
Cosmocephalus firlottei	1	1	1	1	-
Dispharynx sp. (immature)	1	-	-	-	-
Echinuria decorata	0	0	1	1	-
Tropisurus fissispinus	1	1	1	1	-
Spirofilaria fulicae-atrae	1, 2	1, 2	1, 2	-	-
Acanthocephala					
Polymorphus paradoxus	1	1	1	1	-
Hirudinea					
Theromyzon rude	1	1	1	1	0

0 - No new Records

1 - New Host Record

2 - New North American Record

NS - New Species

\- - Not found.

In this study *Cotylurus erraticus* was recovered from one *Podiceps auritus* (immature, collected October 5, 1961 at Lake Wabamun), two *P. grisegena* (adults, collected May 18, 1961 at Lake Wabamun and June 4, 1962 at Barrier Reservoir), and two *Aechmophorus occidentalis* (adults, collected June 26, 1963 at Lake Wabamun). The paucity of records of this parasite is probably correlated with low numbers of birds collected from lakes with fish.

This species was identified with the aid of the keys and description in Dubois (1938 and 1953).

2. *Cotylurus pileatus* (Rudolphi, 1802) Dubois, 1937

Type host: *Sterna hirundo*.

Other recorded hosts: members of the Laridae and Alcidae.

Habitat: small intestine.

Life cycle: metacercariae encyst in the body cavity, pericardial cavity, and muscles of the eye of fish.

Distribution: Europe and Asia.

Cotylurus pileatus was found on six occasions, all in *Aechmophorus occidentalis*: on October 2, 1960 from Lake Wabamun, 3 birds; on October 5, 1961 from Lake Wabamun, 2 birds; and on October 18, 1961 from Pigeon Lake, 1 bird; with 13 to 270 worms.

Because of the small number of *A. occidentalis* collected, no conclusions can be drawn concerning the seasonal incidence of this parasite.

This strigeid was identified using the keys and description of Dubois (1938 and 1953).

3. *Cotylurus platycephalus* (Creplin, 1825) Szidat, 1928

Type host: *Colymbus rufogularis* (= *Gavia stellata*).

Other recorded hosts: *Podiceps cristatus* and members of the Laridae, Alcidae, Phalacrocoracidae, and Accipitridae.

Habitat: bursa of Fabricius, occasionally the cloaca, rectum, or large intestine.

Life cycle: larvae develop in lymnaeid snails, metacercariae encyst in fish (periphery of the heart and in the tissues of the eye).

Distribution: Europe, Western Siberia and North America.

Cotylurus platycephalus was found in all cases in the bursa of Fabricius. The occurrence of this parasite in a breeding *Podiceps auritus* reflected the retention of the bursa in this particular bird. In other breeding birds of this species the bursa was not in evidence. In at least some *P. caspicus* the bursa of Fabricius is retained past the first year, however no strigeids of this species were found in this grebe.

In three of the four occasions that this parasite was found, it was found in the fall in immature birds: *Aechmophorus occidentalis* and *Podiceps auritus* in October and *P. caspicus* in November. The infected *P. auritus* was collected in May.

This species was identified with the aid of keys in Dubois (1953) and the specimens fit his description (1938). The form found in North America is considered a variety by Dubois (1953) - *Cotylurus platycephalus* variety *communis*.

4. *Cotylurus* sp.

On three occasions strigeids were obtained which could be identified only to the genus *Cotylurus* (an adult *Podiceps auritus* collected May 13, 1963, 1/2 mile south of Miquelon Lake contained 2 immature worms; an immature *P. grisegena* collected June 26, 1963, at Lake Wabamun, 1 immature worm; an immature *Aechmophorus occidentalis* collected October 18, 1961 at Pigeon Lake, 2 worms which dried out). All were found in the small intestine, and were probably representatives of the species already discussed.

5. *Apatemon gracilis* (Rudolphi, 1819) Szidat, 1928

Type host: *Mergus merganser*.
Other recorded host: species of the Anatidae.
Habitat: duodenum.
Life cycle: larvae develop in amnicolid snails (*Bithynia* sp.), metacercariae encyst in leeches.
Distribution: Europe, Japan and Alaska.

With the exception of one specimen from the caecum, which was probably the result of contamination, all other specimens recorded were from the duodenum.

Table V provides data on the occurrence of this strigeid in different hosts during the study period.

Apatemon gracilis was identified with the aid of the keys and descriptions in Dubois (1953 and 1938).

Family Diplostomatidae

6. *Tylodelphys podicipina* Kozicka and Niewiadomska, 1960

Type host: *Podiceps cristatus*.

Table V

Incidence of <u>Apatemon gracilis</u> in Four Species of Grebes in Alberta

	Podiceps caspicus				Podiceps auritus			
	No. of birds collected	% infected	Av. no. trematodes per bird*	Range in no. of trematodes	No. of birds collected	% infected	Av. no. trematodes per bird*	Range in no. of trematodes
Adult								
April 16-30	10	20	50	40-60	-	-	-	-
May 1-15	10	0	0	0	5	0	0	0
16-31	12	0	0	0	6	17	5	5
June 1-15	14	21	48	7-111	7	0	0	0
16-30	11	0	0	0	8	0	0	0
July 1-15	12	25	24	1-50	5	20	2	2
16-31	12	42	3	1- 8	8	0	0	0
Aug. 1-15	21	29	11	1-50	5	0	0	0
16-31	-	-	-	-	-	-	-	-
Sept. 1-15	-	-	-	-	-	-	-	-
16-30	-	-	-	-	1	0	0	0
Oct. 1-15	-	-	-	-	-	-	-	-
16-31	-	-	-	-	-	-	-	-
Total	102	19	21	1-111	45	4	4	2-5
Immature								
June 1-15	-	-	-	-	-	-	-	-
16-30	-	-	-	-	3	0	0	0
July 1-15	1	100	9	9	7	0	0	0
16-31	16	25	9	2-20	6	0	0	0
Aug 1-15	16	31	10	2-22	2	0	0	0
16-31	10	20	45	8-82	9	0	0	0
Sept. 1-15	10	10	2	2	5	0	0	0
16-30	10	0	0	0	4	0	0	0
Oct. 1-15	-	-	-	-	1	0	0	0
16-31	-	-	-	-	-	-	-	-
Nov. 1-15	1	0	0	0	-	-	-	-
Total	64	20	15	2-82	37	0	0	0

cont'd

Table V (cont'd)

	Podiceps grisegena				*Aechmophorus occidentalis*			
	No. of birds collected	% infected	Av. no. trematodes per bird*	Range in no. of trematodes	No. of birds collected	% infected	Av. no. trematodes per bird*	Range in no. of trematodes
Adult								
April 16-30	-	-	-	-	-	-	-	-
May 1-15	5	40	151	2-300	1	0	0	0
16-31	6	67	12	5- 25	-	-	-	-
June 1-15	8	13	44	44	3	33	175	175
16-30	6	83	16	2- 32	4	0	0	0
July 1-15	5	40	8	2- 13	-	-	-	-
16-31	4	0	0	0	-	-	-	-
Aug. 1-15	-	-	-	-	-	-	-	-
16-31	-	-	-	-	-	-	-	-
Sept. 1-15	-	-	-	-	-	-	-	-
16-30	-	-	-	-	-	-	-	-
Oct. 1-15	-	-	-	-	-	-	-	-
16-31	-	-	-	-	1	0	0	0
Total	34	41	35	2-300	9	11	175	175
Immature								
June 1-15	1	0	0	0	-	-	-	-
16-30	8	0	0	0	-	-	-	-
July 1-15	15	40	8	2- 13	-	-	-	-
16-31	4	0	0	0	7	0	0	0
Aug. 1-15	-	-	-	-	-	-	-	-
16-31	5	20	15	15	-	-	-	-
Sept. 1-15	1	100	2	2	-	-	-	-
16-30	-	-	-	-	-	-	-	-
Oct. 1-15	-	-	-	-	3	0	0	0
16-31	-	-	-	-	2	0	0	0
Nov. 1-15	-	-	-	-	-	-	-	-
Total	34	21	7	2- 15	12	0	0	0

* Per infected bird.

Other recorded hosts: P. grisegena, P. nigricollis (= Podiceps caspicus).
Habitat: small intestine.
Life cycle: metacercariae are found in the eyes of fish (Kozicka and Niewiadomska, 1960).
Distribution: Poland.

Tylodelphys podicipina was found in eight immature Aechmophorus occidentalis, all collected in the fall. Only the adults of Podiceps grisegena were infected (May 18, 1961 at Lake Wabamun - 75 trematodes; June 4, 1962 at Barrier Reservoir - undetermined number; June 26, 1963 at Lake Wabamun - 20 trematodes). All the infected birds came from larger lakes in which fish were available.

Family Schistosomatidae

7. Dendritobilharzia anatinarum Cheatum, 1941

Type host: Anas platyrhynchos.
Other recorded hosts: none.
Habitat: dorsal aorta.
Life cycle: unknown, probably involves direct penetration of the bird by the cercaria.
Distribution: New York.

In this study Dendritobilharzia anatinarum was found in the kidney of a specimen of Podiceps caspicus collected July 3, 1962 in the Hay Lakes area.

It was identified as Dendritobilharzia by J. C. Holmes, and closely resembles D. anatinarum. It differs in several measurements from the original description. Egg size shows the most important difference (0.060-0.065 mm. in D. anatinarum, as compared to 0.075-0.080 mm. in the specimen from the grebe).

However, because of the general agreement in measurements and proportions, this specimen has been referred to *D. anatinarum*. The identification was made with the use of the keys in Skrjabin (1964) and the description in Cheatum (1941).

No special efforts were made to find these flukes, so the true incidence of this trematode in grebes is unknown.

Order Echinostomida

Family Echinostomatidae

8. *Echinostoma revolutum* (Froelich, 1802) Looss, 1899

Type host: unknown.

Other recorded hosts: a wide variety of birds, especially anatids; occasionally mammals.

Habitat: intestine.

Life cycle: larvae develop in snails (*Lymnaea*, *Physa*, and *Valvata*), then encyst in the snail, on other snails, or in tadpoles.

Distribution: cosmopolitan.

In grebes this parasite was found in one adult *Podiceps caspicus*, one adult *P. grisegena*, six adult and one immature *P. auritus*. It occurred in May, June, July and August and appeared to be an accidental parasite of grebes.

It was found in the intestine and on three occasions it was found in the cloaca and once in the caeca.

Echinostoma revolutum was identified using the keys in Skrjabin (1964). Many specimens were identified by J. C. Holmes.

9. *Petasiger nitidus* Linton, 1928

Type host: *Colymbus auritus* (= *Podiceps auritus*).

Other recorded hosts: experimentally in canaries.
Habitat: small intestine.
Life cycle: larvae develop in _Helisoma_, encyst in the esophagus and lower pharynx of fish (_Ameiurus nebulosus_, _Notropis hudsonius_, _Umbra limi_, _Lepomis pallidus_, _Amboplites rupestris_, _Perca flavescens_, and _Lebistes reticulatus_) (Beaver, 1939a).
Distribution: North America.

Table VI shows the occurrence of this trematode in Alberta grebes during the study period.

Petasiger nitidus was identified with the aid of descriptions and discussions in Linton (1928); Beaver (1939a); Johnston and Angel (1941); Abdel-Malek (1952 and 1953); and Odening (1962).

10. _Echinochasmus donaldsoni_ Beaver, 1941

Type host: _Podilymbus podiceps_
Other recorded hosts: experimentally in pigeons.
Habitat: duodenum.
Life cycle: larvae develop in amnicolid snails (_Amnicola limosa_ and _Amnicola lustrica_), encyst on the gills of fish (_Lebistes reticulatus_, _Perca flavescens_, _Mollienisia latipinia_, _Helioperca incisor_, _Umbra limi_, _Ameiurus nebulosus_, _Notropis_ sp., _Eucalia inconstans_, _Pfrille neogaeus_ and _Amia calva_) (Beaver, 1941).
Distribution: Michigan.

Echinochasmus donaldsoni was found on two occasions: an adult _Podiceps auritus_ collected May 15, 1963 at Big Island Lake contained 35 echinostomes; and an _Aechmophorus occidentalis_ collected October 5, 1961 at Lake Wabamun had 75 echinostomes.

Table VI

Incidence of Petasiger nitidus in Five Species of Grebes in Alberta

	Podiceps caspicus				Podiceps auritus			
	No. of birds collected	% infected	Av. no. trematodes per bird	Range in no. of trematodes	No. of birds collected	% infected	Av. no. trematodes per bird	Range in no. of trematodes
Adult								
April 16-30	10	0	0	0	-	-	-	-
May 1-15	10	0	0	0	5	20	25	25
16-31	12	0	0	0	5	0	0	0
June 1-15	14	7	25	25	7	43	39	2-75
16-30	11	0	0	0	8	25	19	12-26
July 1-15	12	8	4	4	4	0	0	0
16-31	12	0	0	0	7	0	0	0
Aug. 1-15	21	14	60	17-100	5	0	0	0
16-31	-	-	-	-	-	-	-	-
Sept. 1-15	-	-	-	-	-	-	-	-
16-30	-	-	-	-	1	0	0	0
Oct. 1-15	-	-	-	-	-	-	-	-
16-31	-	-	-	-	-	-	-	-
Total	102	5	42	4-100	42	14	30	2-75
Immature								
June 1-15	-	-	-	-	-	-	-	-
16-30	-	-	-	-	3	0	0	0
July 1-15	1	0	0	0	8	0	0	0
16-31	16	0	0	0	6	0	0	0
Aug. 1-15	16	13	36	2- 70	2	0	0	0
16-31	10	10	15	15	9	0	0	0
Sept. 1-15	10	0	0	0	5	0	0	0
16-30	10	0	0	0	4	0	0	0
Oct. 1-15	-	-	-	-	1	100	125	125
16-31	-	-	-	-	-	-	-	-
Nov. 1-15	1	0	0	0	-	-	-	-
Total	64	5	29	2- 70	38	8	125	125

cont'd

Table VI (cont'd)

		Podiceps grisegena				Aechmophorus occidentalis			
		No. of birds collected	% infected	Av. no. trematodes per bird	Range in no. of trematodes	No. of birds collected	% infected	Av. no. trematodes per bird	Range in no. of trematodes
Adult									
April	16-30	-	-	-	-	-	-	-	-
May	1-15	5	20	50	50	1	0	0	0
	16-31	6	17	30	30	-	-	-	-
June	1-15	8	50	43	7-100	3	0	0	0
	16-30	6	33	180	10-350	4	0	0	0
July	1-15	5	40	18	15- 20	-	-	-	-
	16-31	4	100	36	10- 75	-	-	-	-
Aug.	1-15	-	-	-	-	-	-	-	-
	16-31	-	-	-	-	-	-	-	-
Sept.	1-15	-	-	-	-	-	-	-	-
	16-30	-	-	-	-	-	-	-	-
Oct.	1-15	-	-	-	-	-	-	-	-
	16-31	-	-	-	-	1	0	0	0
Total		34	41	57	7-350	9	0	0	0
Immature									
June	1-15	1	0	0	0	-	-	-	-
	16-30	8	13	20	20	7	0	0	0
July	1-15	15	33	12	1- 36	-	-	-	-
	16-31	4	75	78	10-175	-	-	-	-
Aug.	1-15	-	-	-	-	-	-	-	-
	16-31	5	40	25	15- 35	-	-	-	-
Sept.	1-15	1	0	0	0	-	-	-	-
	16-30	-	-	-	-	-	-	-	-
Oct.	1-15	-	-	-	-	3	67	29	13-45
	16-31	-	-	-	-	2	0	0	0
Total		34	32	33	1-175	12	17	29	13-45
Podilymbus podiceps									
July	16-31	4	100	30	8- 46				
Aug.	16-31	2	100	65	65				
Total		6	100	42	8- 65				

The keys of Skrjabin (1964) and description of Beaver (1941) were used to identify this echinostome.

11. Stephanoprora pseudoechinata (Olsen, 1876) Yamaguti, 1958

Type host: unknown.

Other recorded hosts: Podiceps auritus, P. grisegena, and species of the Laridae and Gaviidae.

Habitat: intestine.

Life cycle: unknown.

Distribution: Europe, Russia, and North America.

This echinostome was found on two occasions: one adult Podiceps caspicus collected April 28, 1964 at Cooking Lake contained 4 trematodes; and one adult P. auritus collected April 21, 1961 in Michigan contained 5 trematodes.

Stephanoprora pseudoechinata was identified with the aid of the description in Linton (1928) and the keys in Skrjabin (1964).

Family Cathaemasiidae

12. Ribeiroia thomasi (McMullen, 1938) Yamaguti, 1958

Type host: Pandion haliaetus.

Other recorded hosts: species of the Accipitridae, Ciconiiformes; and experimentally in chickens, ducks, pigeons, and canaries.

Habitat: esophagus.

Life cycle: larvae develop in Helisoma, encyst in the lateral line canal of freshwater fish (Beaver, 1939b).

Distribution: Africa and North America.

Ribeiroia thomasi was found in the esophagus of two

grebes, in the proventriculus of ten and in the small intestine of one. Infections included one adult and two immature *Podiceps grisegena*, one adult and five immature *P. auritus*, two immature *Podilymbus podiceps*, and one immature *Aechmophorus occidentalis*. The infections occurred from June to October.

Ribeiroia thomasi was identified with the aid of the keys in Yamaguti (1958) and the description in Mettrick (1963).

Family Notocotylidae

13. *Notocotylus attenuatus* (Rudolphi, 1809) Diesing, 1839

Type host: *Scolopax gallinago*.
Other recorded hosts: species of the Anatidae, Phalaropodidae, and Scolopacidae.
Habitat: intestine.
Life cycle: larvae in snails, cercariae encyst on the surface of objects in the water.
Distribution: cosmopolitan.

On both occasions that this trematode was found it was in the caeca. It was found in an immature *Podiceps grisegena* collected August 30, 1963 at Big Island Lake - 3 trematodes; and in an immature *P. auritus* collected 5 miles east of Ellerslie on July 7, 1960 - 2 trematodes.

This notocotylid was identified with the aid of the keys in Skrjabin (1964) and Dubois (1951).

Order Plagiorchiida

Family Eucotylidae

14. *Eucotyle cohni* Skrjabin, 1924

Type host: *Podiceps nigricollis* (= *Podiceps caspicus*).

Other recorded hosts: P. grisegena, and Gavia arctica.

Habitat: urinary tubules of the kidney.

Life cycle: unknown, another genus in this family (Tanaisia Skrjabin, 1924) has larvae in land snails, in which the cercariae also encyst. Eucotyle may have the same type of life cycle but use aquatic snails.

Distribution: Russia.

Eucotyle cohni occurred on two occasions in Podiceps caspicus, both were adult birds; three times in P. grisegena (adults); and fifteen times in P. auritus (14 adults and 1 immature). Table VII illustrates the occurrence of this parasite in P. auritus. The paucity of infections in immature birds is totally unexplained. Perhaps it could be the result of long development in the intermediate host or a low level of infection of intermediate hosts in this area.

Family Microphallidae

15. Maritrema japonicum (Yamaguti, 1939) Etges, 1953

Type host: Histrionicus histrionicus pacificus.

Other recorded hosts: Melanitta fusca stejnegeri.

Habitat: caeca.

Life cycle: unknown, other members of the genus develop in marine snails and encyst in marine isopods (Carrere, 1936).

Distribution: Japan, USSR (Primoria).

Trematodes identified to this species were found on three occasions: 31 from an adult Podiceps grisegena collected June 4, 1962 at Barrier Reservoir; one from the intestine of an adult P. grisegena collected June 16, 1959 near Aklavik, NWT.;

Table VII

Incidence of Eucotyle cohni in Podiceps auritus in Alberta.

		No. of birds collected	% infected	Av. no. of trematodes per bird	Range in no. of trematodes
Adult					
May	1-15	5	20	31	31
	16-31	6	0	0	0
June	1-15	6	17	4	4
	16-30	8	50	10	4-25
July	1-15	4	25	3	3
	16-31	8	25	25	7-43
Aug.	1-15	5	100	18	1-68
	16-31	-	-	-	-
Sept	1-15	-	-	-	-
	16-30	1	0	0	0
Total		43	33	16	1-68
Immature					
June	16-30	3	0	0	0
July	1-15	8	0	0	0
	16-31	2	0	0	0
Aug.	1-15	2	0	0	0
	16-31	9	0	0	0
Sept.	1-15	4	25	25	25
	16-30	5	0	0	0
Total		33	3	25	25

and nine from an adult *P. caspicus* collected July 3, 1962 in the Hay Lakes area.

This trematode appears to be a parasite brought in from the wintering grounds, accidental for this area.

Maritrema japonicum was identified with the aid of the keys in Skrjabin (1964) and the description and discussions in Coil (1955), Etges (1953), and Hunter and Vernberg (1953). The specimens collected from the grebes do not completely agree with the measurements given by Yamaguti, but because of the very similar proportions and arrangement of organs they are tentatively identified as *M. japonicum*. The Alberta forms also differ slightly from the trematodes collected near Aklavik, NWT. (Table VIII).

Family Plagiorchiidae

16. *Plagiorchis maculosus* (Rudolphi, 1802) Braun, 1901

Type host: *Hirundo rustica*.

Other recorded hosts: species of the Sciuridae, Hirundinidae, Sturnidae, Caprimulgidae, Fringillidae, Motacillidae, Laridae, Accipitridae, Paridae and Anatidae.

Habitat: intestine and caecum.

Life cycle: larvae in lymnaeid snails, xiphidiocercariae encyst in chironomid larvae and also in larvae of *Chaoborus* and *Culex*.

Distribution: Europe and Asia.

Ten trematodes were collected from a *Podiceps grisegena* taken June 16, 1959 near Aklavik, NWT.; and one was found in a *Podilymbus podiceps* taken near Bremner on July 23, 1962.

Table VIII

Variation of *Maritrema japonicum* in *Histrionicus histrionicus pacificus* and in Three Species of Grebes.

	Histrionicus histrionicus	*P. grisegena* (Alberta)	*P. grisegena* (N.W.T.)	*P. caspicus* (Alberta)
Length	0.7-1.2 mm.	1.2 mm.	1.53 mm.	2.02 mm.
Width	0.25-0.46 mm.	0.4 mm.	0.57 mm.	0.44 mm.
Oral Sucker (Dia.)	0.060 x 0.090 mm.	0.135 x 0.120 mm.	0.150 x 0.120 mm.	0.135 x 0.105 mm.
Acetabulum (Dia.)	0.07 x 0.12 mm.	0.135 x 0.165 mm.	0.150 x 0.150 mm.	0.165 x 0.165 mm.
Vitellaria	6-8 follicles	7 follicles	6 follicles	7-9 follicles
Eggs	0.024 x 0.029 mm.	0.011 x 0.019 mm.	0.015 x 0.030 mm.	0.012 x 0.015 mm.

Plagiorchis maculosus was identified with the aid of the keys in Olsen (1937). The specimens taken from Alberta grebes differed from those described by Olsen in the amount of vitellaria (more extensive in the grebe specimens) and eggs (larger and narrower in the grebe specimens). These differences are not considered to be significant because of the acknowledged variability in this trematode (Angel, 1959).

Order Opisthorchiida

Family Heterophyidae

17. *Galactosomum humbargari* Park, 1936

Type host: *Larus californicus*.
Other recorded hosts: species of the Laridae.
Habitat: small intestine.
Life cycle: metacercariae encyst in *Leuresthes tenuis* (saltwater teleost) (Olsen in Yamaguti, 1958).
Distribution: California and Washington.

This specimen was identified by J. C. Holmes from a *Podiceps grisegena* collected May 28, 1960 at Big Island Lake. It appears to be an accidental parasite of grebes in this region and is apparently a marine animal brought in from the Pacific wintering grounds.

Family Orchipedidae

18. *Orchipedum tracheicola* Braun, 1901

Type host: *Anas fusca*.
Other recorded hosts: species of the Anatidae.

Habitat: trachea of birds.
Life cycle: unknown.
Distribution: Europe and North America.

In grebes *Orchipedum tracheicola* is seen in the early spring but apparently never matures. Thirteen of 45 *Podiceps caspicus*, five of five *P. grisegena*, and one of 11 *P. auritus* examined in the spring were infected. On only two other occasions were these worms found: one immature *P. auritus* collected August 30, 1963 was infected with one worm and one immature *P. caspicus* taken on September 17, 1962 was infected with two worms.

The trematodes were found on 19 occasions in the trachea, on eight in the lungs and one in the kidneys. The last may have been due to contamination as the bird had been shot in the body.

Orchipedum tracheicola was identified with the aid of the keys in Skrjabin (1964). Although the worms were not mature, enough development had occurred so that this identification could be made.

Cestoda

Order Pseudophyllidea

Family Diphyllobothriidae

19. *Ligula intestinalis* (Linnaeus, 1758) Bloch, 1782

Type host: none.
Other recorded hosts: a wide variety of fish-eating

birds and occasionally mammals.

Habitat: intestine.

Life cycle: procercoids in *Cyclops*, plerocercoids in fish (*Perca*, *Esox*, *Catastomus*, *Salvelinus*, *Salmo*, *Notropis*, *Coregonus*, etc.).

Distribution: Europe, Asia, and North America.

Table IX presents data on the seasonal occurrence of *Ligula intestinalis* in four species of Alberta grebes.

20. *Schistocephalus solidus* (Mueller, 1776) Creplin, 1829

Type host: none.

Other recorded hosts: a wide variety of fish-eating birds.

Habitat: small intestine.

Life cycle: procercoids in copepods (*Cyclops*), plerocercoids in fish (*Cottus*, *Gasterosteus*, *Salvelinus*, *Uronidea*, *Pygosteus*, etc.).

Distribution: Europe, Asia and North America.

Table X illustrates the occurrence of this parasite in Alberta grebes. Like *Ligula intestinalis* this cestode has a very short life span.

Schistocephalus solidus was identified with the aid of Linton (1927) and the description in Wardle and McLeod (1952).

Order Cyclophyllidea

Family Tetrabothriidae

21. *Tetrabothrius immerinus* (Abildgaard, 1790) Baer, 1954

Type host: unknown.

Other recorded hosts: *Gavia arctica*, *G. stellata*, *Colymbus auritus* (= *Podiceps auritus*), *C. cristatus* (= *P. cristatus*), *Somateria mollissima*, and

Table IX

Incidence of *Ligula intestinalis* in Four Species of Grebes in Alberta.

		Podiceps caspicus				*Podiceps auritus*			
		No. of birds collected.	% infected	Av. no. of cestodes per bird	Range in no. of cestodes	No. of birds collected	% infected	Av. no. of cestodes per bird	Range in no. of cestodes
Adults									
April	16-30	10	0	0	0	-	-	-	-
May	1-15	10	0	0	0	5	0	0	0
	16-31	12	0	0	0	6	33	1	1
June	1-15	14	0	0	0	7	0	0	0
	16-30	11	0	0	0	8	0	0	0
July	1-15	12	0	0	0	5	0	0	0
	16-31	12	0	0	0	8	0	0	0
Aug.	1-15	21	19	6	2-17	5	20	1	1
	16-31	-	-	-	-	-	-	-	-
Sept.	1-15	-	-	-	-	-	-	-	-
	16-30	-	-	-	-	1	0	0	0
Total		102	4	6	2-17	45	7	1	1
Immature									
June	16-30	-	-	-	-	3	0	0	0
July	1-15	1	0	0	0	7	0	0	0
	16-31	16	6	1	1	6	0	0	0
Aug.	1-15	16	19	3	1-17	2	0	0	0
	16-31	10	0	0	0	9	0	0	0
Sept.	1-15	10	0	0	0	5	0	0	0
	16-30	10	0	0	0	4	0	0	0
Oct.	1-15	-	-	-	-	1	100	3	3
	16-31	-	-	-	-	-	-	-	-
Nov.	1-15	1	100	9	9	-	-	-	-
Total		64	8	4	1-17	37	3	3	3

cont'd

Table IX (cont'd)

		Podiceps grisegena				Aechmophorus occidentalis			
		No. of birds collected	% infected	Av. no. of cestodes per bird	Range in no. of cestodes	No. of birds collected	% infected	Av. no. of cestodes per bird	Range in no. of cestodes
Adult									
April	16-30	-	-	-	-	-	-	-	-
May	1-15	5	40	2	1- 3	1	0	0	0
	16-31	6	17	60	60	-	-	-	-
June	1-15	9	33	29	1-47	3	67	31	26-36
	16-30	6	0	0	0	4	50	2	1- 3
July	1-15	5	0	0	0	-	-	-	-
	16-31	4	0	0	0	-	-	-	-
Aug.	1-15	-	-	-	-	-	-	-	-
	16-31	-	-	-	-	-	-	-	-
Sept.	1-15	-	-	-	-	-	-	-	-
	16-30	-	-	-	-	-	-	-	-
Oct.	1-15	-	-	-	-	-	-	-	-
	16-31	-	-	-	-	1	100	9	9
Total		35	17	25	1-47	9	56	15	1-36
Immature									
June	1-15	1	0	0	0	-	-	-	-
	16-30	8	0	0	0	7	14	1	1
July	1-15	15	0	0	0	-	-	-	-
	16-31	4	0	0	0	-	-	-	-
Aug.	1-15	-	-	-	-	-	-	-	-
	16-31	5	0	0	0	-	-	-	-
Sept.	1-15	1	0	0	0	-	-	-	-
	16-30	-	-	-	-	1	0	0	0
Oct.	1-15	-	-	-	-	5	60	22	2-40
	16-31	-	-	-	-	2	100	22	4-39
Total		34	0	0	0	15	40	19	1-40

Table X

Incidence of Schistocephalus solidus in Four Species of Grebes in Alberta.

		Podiceps caspicus				*Podiceps auritus*			
		No. of birds collected	% infected	Av. no. of cestodes per bird	Range in no. of cestodes	No. of birds collected	% infected	Av. no. of cestodes per bird	Range in no. of cestodes
Adult									
April	16-30	10	0	0	0	-	-	-	-
May	1-15	10	0	0	0	5	0	0	0
	16-31	12	0	0	0	6	0	0	0
June	1-15	14	0	0	0	7	0	0	0
	16-30	11	0	0	0	8	0	0	0
July	1-15	12	0	0	0	5	0	0	0
	16-31	12	0	0	0	8	13	1	1
Aug.	1-15	21	5	1	1	5	0	0	0
	16-31	-	-	-	-	-	-	-	-
Sept.	1-15	-	-	-	-	-	-	-	-
	16-30	-	-	-	-	1	0	0	0
Oct.	1-15	-	-	-	-	-	-	-	-
	16-31	-	-	-	-	-	-	-	-
Total		102	1	1	1	45	2	1	1
Immature									
June	16-30	-	-	-	-	3	0	0	0
July	1-15	1	0	0	0	7	0	0	0
	16-31	16	0	0	0	6	0	0	0
Aug.	1-15	16	0	0	0	2	50	2	2
	16-31	10	40	8	1-19	9	0	0	0
Sept.	1-15	10	10	1	1	5	40	1	1
	16-30	10	20	3	1- 4	4	0	0	0
Oct.	1-15	-	-	-	-	1	0	0	0
	16-31	-	-	-	-	-	-	-	-
Nov.	1-15	1	0	0	0	-	-	-	-
Total		64	10	6	1-19	37	8	1	1-2

cont'd

Table X (cont'd)

		Podiceps grisegena				*Aechmophorus occidentalis*			
		No. of birds collected	% infected	Av. no. of cestodes per bird	Range in no. of cestodes	No. of birds collected	% infected	Av. no. of cestodes per bird	Range in no. of cestodes
Adult									
May	1-15	5	0	0	0	1	0	0	0
	16-31	6	0	0	0	-	-	-	-
June	1-15	10	20	1	1	3	0	0	0
	16-30	6	0	0	0	4	0	0	0
July	1-15	5	20	1	1	-	-	-	-
	16-31	4	25	5	5	-	-	-	-
Aug.	1-15	-	-	-	-	-	-	-	-
	16-31	-	-	-	-	-	-	-	-
Sept.	1-15	-	-	-	-	-	-	-	-
	16-30	-	-	-	-	-	-	-	-
Oct.	1-15	-	-	-	-	-	-	-	-
	16-31	-	-	-	-	1	100	1	1
Total		36	11	2	1-5	9	11	1	1
Immature									
June	1-15	1	100	1	1	-	-	-	-
	16-30	8	25	2	2	7	0	0	0
July	1-15	15	0	0	0	-	-	-	-±
	16-31	4	25	3	3	-	-	-	-
Aug.	1-15	-	-	-	-	-	-	-	-
	16-31	5	40	12	1-23	-	-	-	-
Sept.	1-15	1	0	0	0	-	-	-	-
	16-30	-	-	-	-	1	0	0	0
Oct.	1-15	-	-	-	-	5	0	0	0
	16-31	-	-	-	-	2	50	35	35
Total		34	18	5	1-23	15	7	35	35

Rostratula benghalensis.

Habitat: small intestine.

Life cycle: unknown.

Distribution: Europe and North America.

Mature forms of *Tetrabothrius immerinus* occurred in *Podiceps auritus* and *P. grisegena*. Immature cestodes were found in these hosts and also in an adult *P. caspicus*. Table XI illustrates the seasonal occurrence of mature and immature forms in *P. auritus* and *P. grisegena*.

Tetrabothrius immerinus was identified with the aid of the keys in Yamaguti (1959) and fitted the description of *T. macrocephalus* (=*T. immerinus*) in Linton (1927) and Baer (1954). Although immature worms could not be identified with certainty to this species, they agreed in general shape of the scolex, and are therefore included in this discussion. Immature worms were found on nine of the 17 occasions that this species was found.

22. *Lateriporus* sp. (Plate 1, Figure 1 and 2)

A mature cestode of this genus, apparently representing a new species, on the basis of hook size and morphology, was found in an adult *Podiceps grisegena* collected June 18, 1962 at Big Island Lake. Because of the contracted condition of the single specimen available, this species is not named. The measurements and description given below will facilitate later identification.

Length 25 mm; width 1.1 mm excluding cirri, maximum at about 25 mm from the anterior end; proglottids, maximum dimensions

Table XI

Incidence of Tetrabothrius immerinus and T. sp. (immature) in Two Species of Grebes in Alberta

	Podiceps auritus				Podiceps grisegena			
	No. of birds collected	% infected	Av. no. of cestodes per bird	Range in no. of cestodes	No. of birds collected	% infected	Av. no. of cestodes per bird	Range in no. of cestodes
Adults								
May 1-15	5	20	1	1	5	40	4	2- 5
16-31	6	33	13	1-25	6	17	3	3
June 1-15	7	0	0	0	8	0	0	0
16-30	8	25	1	1	6	50	3	2- 4
July 1-15	4	0	0	0	5	40	43	1-85
16-31	8	13	2	2	4	50	2	1- 2
Aug. 1-15	5	0	0	0	-	-	-	-
16-31	-	-	-	-	-	-	-	-
Sept. 1-15	-	-	-	-	-	-	-	-
16-30	1	0	0	0	-	-	-	-
Total	44	14	5	1-25	34	29	11	1-85
Immature								
June 1-15	-	-	-	-	1	0	0	0
16-30	3	0	0	0	8	0	0	0
July 1-15	6	0	0	0	15	0	0	0
16-31	6	0	0	0	4	0	0	0
Aug. 1-15	2	0	0	0	-	-	-	-
16-31	9	0	0	0	5	0	0	0
Sept. 1-15	4	0	0	0	1	0	0	0
16-30	4	0	0	0	-	-	-	-
Oct. 1-15	1	0	0	0	-	-	-	-
Total	35	0	0	0	34	0	0	0

0.4 x 1.1 mm; scolex 0.63 mm long by 0.57 mm wide; rostellum 0.36 mm long, partially inverted, measured from the anterior edge of the suckers, 0.12 mm wide at the narrowest point; rostellar sac 0.68 mm long by 0.20 mm wide, at the widest point, narrows quickly at the proximal end and bends to one side, muscular; suckers 0.20 - 0.24 mm in diameter, longer than wide, found on the most posterior and broadest part of the scolex; hooks, 16, proximal end of the handle to the tip of the blade, 0.226 mm, end of handle to end of guard, 0.118 mm, end of guard to tip of blade, 0.107 mm; genital pores unilateral; cirrus pouch 0.270 - 0.315 mm long by 0.090 - 0.105 mm wide at 11 mm from the anterior end (maximum size); cirrus 1.275 - 1.450 mm long by 0.075 mm (none were seen fully everted but everted plus inverted gave these measurements), with a bulbous base narrowing gradually to a fine tube 7 - 8 microns in diameter, base of the bulb protected by a projection of the proglottid; cirrus spination, spines small on the bulb, large on the proximal part of the cirrus becoming smaller towards the tip; cirrus retention, retained to the last segment; testes, numerous, because of the contracted state of the worm no accurate measurements could be made, but the maximum size appears to be 30 - 45 microns; vas deferens, muscular and convoluted, lying in the median anterior part of the proglottid; female organs, not seen, except for the uterus which appears about 4 mm from the anterior end as a sac lying aporally; eggs, 0.150 - 0.195 mm in diameter, inner shell 0.045 - 0.075 mm in diameter.

23. Lateriporus sp. (immature) (Plate 2, Figures 3, 4 and 5)

Immature cestodes identified as belonging to this genus were found on five occasions: an adult Podiceps grisegena collected July 5, 1962 at Big Island Lake - 4 cestodes; an adult P. grisegena collected July 9, 1962 at Big Island Lake -

1 cestode; an adult P. caspicus collected June 7, 1962 at Big Island Lake - 1 cestode; and an immature P. caspicus collected September 4, 1962 at Joseph Lake - 1 cestode. They appear to be all the same species.

Hooks, 14, end of the handle to tip of blade 174 - 196 microns, end of handle to tip of guard 96 - 111 microns, end of guard to tip of blade 78 - 81 microns; suckers 0.26 - 0.30 mm in diameter; rostellum 0.345 mm long by 0.120 mm wide at the base and 0.180 mm wide at the apex; rostellar sac muscular 0.360 mm long by 0.150 mm wide at its widest.

These cestodes are accidentals and there is no evidence that they ever mature.

Family Hymenolepididae

24. Dicranotaenia sp. (Plate 3 and 4, Figures 6 - 10)

This cestode was found in nine Aechmophorus occidentalis (Table XII). It could not be equated to any known species of Dicranotaenia so is thought to be new. It appears closest to D. pingi (Tseng Shen, 1932) Yamaguti, 1959 in size of hooks and arrangement of organs but differs in several important measurements as is indicated in Table XIII.

Species of this genus have larval forms in Cyclops, Cypris and Candona.

25. Diorchis sp. (Plate 6, Figure 17 and 18)

Cestodes identified as Diorchis sp. were found in Podiceps caspicus and P. grisegena. These cestodes, on the basis of strobila size, rostellar length and hook morphology, could

Table XII

Incidence of Dicranotaenia sp. in Aechmophorus occidentalis in Alberta.

		No. of birds collected	% infected	Av. no. of cestodes per bird	Range in no. of cestodes
Adults					
May	1-15	1	100	100	100
	16-31	-	-	-	-
June	1-15	2	50	10	10
	16-30	4	100	56	20-125
July	1-15	-	-	-	-
	16-31	-	-	-	-
Aug.	1-15	-	-	-	-
	16-31	-	-	-	-
Sept.	1-15	-	-	-	-
	16-30	-	-	-	-
Oct.	1-15	-	-	-	-
	16-31	1	100	11	11
Total		8	88	49	10-125
Immature					
June	16-30	7	0	0	0
July	1-15	-	-	-	-
	16-31	-	-	-	-
Aug.	1-15	-	-	-	-
	16-31	-	-	-	-
Sept.	1-15	-	-	-	-
	16-30	-	-	-	-
Oct.	1-15	3	33	5	5
	16-31	2	50	1	1
Total		12	17	8	1-5

Table XIII

A Comparison of Specimens of *Dicranotaenia pingi** from *Anas segetum* and *Dicranotaenia* sp. from *Aechmophorus occidentalis* .

(all measurements in microns except where stated otherwise)

	Dicranotaenia pingi	*Dicranotaenia* sp.
Length	200.0 mm.	330.0 mm.
Width	3.0 mm.	2.2 mm.
Scolex	342 x 228	270 x 255
Sucker dia.	96 - 100	75 - 90
Rostellum	205 x 125	120 x 60
Hooks no.	10	10
	21 - 23	18.5 - 20
Neck	425 x 306	400 - 450 x 210
Proglottids - imm.	200 x 16	135 x 15
mature	2.0 mm x 255	1.5 mm x 120
gravid	3.0 mm x 340	2.2 mm x 225
Testes (trans dia.)	182 - 319	75 - 120
Cirrus pouch	364 - 689 x 57 - 119	345 - 450 x 45 - 60
Ovary (trans dia.)	342	675 - 705
Vitelline gland	57	165 - 210
	not lobed	lobed

* Tseng Shen, 1932

not be assigned to any known species. They most closely resemble Diorchis microcirrosus Mayhew, 1925, but differ in hook and cirrus morphology. They apparently represent a new species, but because of the poor condition of the material a full description will have to await the collection of fresh specimens.

Description: 18 - 21 by 0,12 - 0.20 mm; rostellar length, 0.20 - 0.24 mm, width, 0.02 - 0.03 mm at the narrowest point, with an expansion at the tip, 0.06 - 0,07 mm in diameter; rostellar sac, 0.05 - 0.06 mm; suckers, 0.04 - 0.05 mm in diameter; hooks, 10, 29.6 - 33.3 microns in length; cirrus, 18 - 26 microns, spined; egg rounded, outer shell 37 - 52 microns in diameter, inner shell 22 - 30 microns in diameter.

Table XIV illustrates the extensity of this parasite in Podiceps caspicus. Because this and several other similar shaped cestodes (Hymenosphenacanthus sp. #1, Dubininolepis podicipina, and D. furcifera) from P. caspicus were not separated at autopsy no accurate measure of intensity was obtained. However these worms were fairly numerous; more than 50 were usually found in a single bird. About 100 specimens were also found in an adult P. grisegena collected June 18, 1962 at Big Island Lake.

26. Dubininolepis furcifera (Krabbe, 1869) Spassky and Spasskaja, 1954. (Plate 5, Figure 11 and 12)

Type host: Podiceps cristatus.
Other recorded hosts: grebes.
Habitat: small intestine.
Life cycle: cysticercoids probably encysted in aquatic crustaceans as related forms are.
Distribution: Europe, Siberia, North America. In

Table XIV

Incidence of Diorchis sp. in Podiceps caspicus in Alberta.

		No. of birds collected	% infected
Adults			
April	16-30	10	10
May	1-15	10	10
	16-31	12	0
June	1-15	13	0
	16-30	11	9
July	1-15	12	33
	16-31	12	75
Aug	1-15	21	48
Total		101	26
Immatures			
July	1-15	1	100
	16-31	16	29
Aug.	1-15	16	38
	16-31	10	70
Sept.	1-15	10	10
	16-30	10	40
Oct.	1-15	-	-
	16-31	-	-
Nov.	1-15	1	0
Total		64	38

Canada it has been reported from Quebec (Mahon, 1956).

Dubininolepis furcifera is the most common cestode in Alberta grebes. It was found in all five species, in most of the individuals, and frequently reached intensities of 100 or more per bird (Table XV). It was not possible to estimate the numbers of this cestode in Podiceps caspicus because they were not separated from several other similarly shaped cestodes.

Dubininolepis furcifera was identified with the aid of the descriptions in Linton (1927), Voge and Read (1954), Mahon (1956) and Korpaczewska (1960) and the comparison of related species in Joyeux and Baer (1950).

As mentioned by Korpaczewska D. furcifera varies in size with different hosts, not only in the thickness and length of the strobila but also in the hook size. A definite difference in size of cestodes (and their hooks) from different hosts was also noted in this survey. The cestodes from Podiceps auritus and P. grisegena appeared to surpass the cestodes from P. caspicus in robustness and hook size, although the ranges overlapped. Not enough specimens were obtained from Podilymbus podiceps to make a comparison with them possible (Table XVI).

Korpaczewska found that the handle, and to a lesser extent the guard, grew with age so that the most stable measurement was the blade length. This appears to be the case in the present data also. A comparison of blade lengths of worms from the three species of hosts shows that worms from P. caspicus have smaller hooks than the others and that those from P. auritus

Table XV

Incidence of Dubininolepis furcifera in Five Species of Grebes in Alberta

		Podiceps caspicus				Podiceps auritus			
		No. of birds collected	% infected	Av. no. of cestodes per bird	Range in no. of cestodes	No. of birds collected	% infected	Av. no. of cestodes per bird	Range in no. of cestodes
Adults									
April	16-30	10	50			-	-	-	-
May	1-15	10	90			5	100	187	12-575
	16-31	11	73			5	100	230	100-350
June	1-15	13	92			7	100	87	8-250
	16-30	11	91			8	100	59	15-200
July	1-15	12	50			4	100	100	50-200
	16-31	12	92			8	100	113	10-250
Aug.	1-15	21	76			5	60	36	9- 75
	16-31	-	-			-	-	-	-
Sept.	1-15	-	-			-	-	-	-
	16-30	-	-			1	100	5	5
Total		100	77			43	95	112	5-575
Immatures									
June	16-30	-	-			3	33	50	50
July	1-15	1	0			6	0	0	0
	16-31	16	50			6	33	88	75-100
Aug.	1-15	16	63			2	100	20	15- 25
	16-31	10	80			9	89	68	1-250
Sept.	1-15	10	80			4	75	142	50-250
	16-30	9	78			4	75	92	1-200
Oct.	1-15	-	-			1	100	150	150
	16-31	-	-			-	-	-	-
Nov.	1-15	1	100			-	-	-	-
Total		63	67			35	57	83	1-250

cont'd

Table XV (cont'd)

	Podiceps grisegena				*Aechmophorus occidentalis*			
	No. of birds collected	% infected	Av. no. of cestodes per bird	Range in no. of cestodes	No. of birds collected	% infected	Av. no. of cestodes per bird	Range in no. of cestodes
Adults								
May 1-15	5	60	87	50-135	1	0	0	0
16-31	5	100	103	25-150	1	100	250	250
June 1-15	8	88	45	15-100	-	-	-	-
16-30	6	67	219	75-400	4	25	10	10
July 1-15	5	100	175	50-400	-	-	-	-
16-31	4	100	81	25-150	-	-	-	-
Aug. 1-15	-	-	-	-	-	-	-	-
16-31	-	-	-	-	-	-	-	-
Sept. 1-15	-	-	-	-	-	-	-	-
16-30	-	-	-	-	-	-	-	-
Oct. 1-15	-	-	-	-	-	-	-	-
16-31	-	-	-	-	1	100	35	35
Total	33	85	113	15-400	7	43	98	10-250
Immatures								
June 1-15	1	0	0	0	-	-	-	-
16-30	8	13	1	1	7	0	0	0
July 1-15	14	71	33	5-150	-	-	-	-
16-31	4	50	150	50-250	7	-	-	-
Aug. 1-15	-	-	-	-	-	-	-	-
16-31	5	40	155	10-300	-	-	-	-
Sept. 1-15	1	100	10	10	-	-	-	-
16-30	-	-	-	-	-	-	-	-
Oct. 1-15	-	-	-	-	3	100	312	85-1000
16-31	-	-	-	-	2	100	250	250
Total	33	49	59	1-300	12	36	287	85-1000
Podilymbus podiceps								
July 16-31	4	0	0	0				
Aug. 16-31	2	50	2	2				
Total	6	17	2	2				

Table XVI

Size of Rostellar Hooks of *D. furcifera* From Three Species of Grebes (in microns)

	P. grisegena	*P. auritus*	*P. caspicus*
No. examined	5	5	5
Total length	35 (33 - 37)	36 (26 - 41)	29 (22 - 32)
Handle	17 (15 - 19)	16 (7 - 20)	10 (7 - 13)
Guard	12 (11 - 13)	10 (9 - 11)	9 (7 - 11)
Blade	19 (17 - 20)	21 (19 - 22)	17 (15 - 19)

Figure 2

D. furcifera - hook.

have the largest hooks. Perhaps this could be a measure of the normality of the infection, with *P. auritus* being the most typical host (it also has the greatest extensity of infection) and *P. caspicus* the least. Or it could be a result of competition with other cestodes of the same general size and shape, which are more common in *P. caspicus* (*Diorchis* sp., *Dubininolepis podicipina*, and *Hymenosphenacanthus* sp. #1).

27. *Dubininolepis podicipina* (Szymanski, 1905) Spassky and Spasskaja, 1954 (Plate 5, Figure 13 and 14)

Type host: *Podiceps auritus*.
Other recorded host: none.
Habitat: small intestine.
Life cycle: unknown, probably involves larvae in crustaceans.
Distribution: Europe.

Dubininolepis podicipina was found in 31.1 percent of the *Podiceps caspicus* collected (Table XVII).

This cestode is not a synonym of *D. furcifera* as is indicated by some authors (Joyeux and Baer, 1950 and Korpazewska, 1960). Specimens from *P. caspicus* matched Szymanski's description nearly exactly and are quite different from *D. furcifera*. The specimens of *D. podicipina* are much more robust than those of *D. furcifera* and the hooks are a different shape (much larger and stronger). Perhaps the best evidence for separating them is the fact that both species were found in the same bird.

Dubininolepis podicipina was identified with the aid of the description in Szymanski (1905) and the key and illustrations in Hughes (1941).

Table XVII

Incidence of Dubininolepis podicipina

in Podiceps caspicus in Alberta

	No. of birds collected	% infected
Adults		
April 16-30	10	60
May 1-15	10	60
16-31	11	36
June 1-15	13	39
16-30	11	91
July 1-15	12	67
16-31	12	0
Aug 1-15	29	43
Total	101	48
Immatures		
July 1-15	1	0
16-31	16	13
Aug. 1-15	16	6
16-31	10	0
Sept. 1-15	10	0
16-30	10	0
Oct. 1-15	-	-
16-31	-	-
Nov. 1-15	1	0
Total	64	8

28. Hymenosphenacanthus sp. #1 (Plate 6, Figure 15 and 16)

Cestodes identified to this genus were found in 7.8 percent of the Podiceps caspicus collected (Table XVIII) and in one adult P. grisegena collected June 17, 1963 at Big Island Lake.

A literature search revealed that this is a new species, differing from most of the other species in the size and shape of the strobila and from all of the others in hook morphology. The brief description which follows will be enlarged and published at a later date:

Length up to 20 mm; width nearly constant throughout its length, 0.12 - 0.18 mm; scolex, 0.30 - 0.32 x 0.29 - 0.30 mm, widest at the level of the suckers; rostellum, 0.26 - 0.27 x 0.07 - 0.08 mm narrowing to 0.06 - 0.07 mm behind the wider apical portion (0.09 - 0.10 mm); rostellar sac, 0.33 - 0.35 x 0.06 - 0.08 mm; suckers, 0.11 - 0.15 mm in diameter; hooks 10, from proximal end of handle to tip of blade, 137 -141 microns, from proximal end of handle to tip of guard, 63 - 67 microns, from tip of guard to tip of blade, 70 - 74 microns; neck short, 0.23 - 0.30 mm; proglottids, immature, 0.02 - 0.03 x 0.13 - 0.14 mm, mature, 0.02 - 0.03 x 0.15 - 0.16 mm, gravid 0.09 - 0.11 x 0.17 - 0.18 mm; testes 3, 0.015 - 0.019 mm in diameter (mature); ovary, 0.030 - 0.037 mm in diameter (mature); vitelline gland, 0.015 - 0.019 mm; eggs, outer shell, 0.033 - 0.037 mm in diameter, inner shell, 0.022 - 0.030 mm in diameter.

29. Hymenosphenacanthus sp. #2 (Plate 7, Figures 19 - 22)

Twenty-five specimens of this new species of cestode were found in one adult Podiceps grisegena collected June 11, 1962 at Big Island Lake. These specimens differed from all described species in hook morphology and in the groups of spines

Table XVIII

Incidence of *Hymenosphenacanthus* sp. 1

in *Podiceps caspicus* in Alberta.

		No. of birds examined	% infected
Adults			
April	16-30	10	0
May	1-15	10	0
	16-31	12	0
June	1-15	14	0
	16-30	11	0
July	1-15	12	0
	16-31	12	50
Aug.	1-15	21	14
Total		102	7
Immatures			
July	1-15	1	0
	16-31	16	6
Aug.	1-15	16	13
	16-31	10	20
Sept.	1-15	10	0
	16-30	10	10
Oct.	1-15	-	-
	16-31	-	-
Nov.	1-15	1	0
Total		64	9

at the edges of the proglottids. Only a short description will be given at this time; a more complete description will be published later:

Length up to 4 mm, but none were seen that were mature; width increases gradually to 0.90 mm so that the strobila appears wedge-shaped; scolex, 0.240 - 0.255 x 0.255 - 0.270 mm, widest at the level of the suckers; rostellum, 0.259 - 9.278 x 0.059 - 0.067 mm, widest in the middle narrowing gradually proximally and sharply distally at the area on which the hooks are attached (0.041 - 0.044 mm); rostellar sac, 0.203 - 0.220 x 0.070 - 0.078 mm; suckers, 0.111 - 0.122 mm in diameter; hooks 8, from proximal end of handle to tip of blade, 78 - 84 microns, from proximal end of handle to tip of guard, 30 - 33 microns, from tip of guard to tip of blade, 56 - 59 microns; neck very short, 0,037 - 0.048 mm; edges of the proglottids with very curious half circle of spines (3.7 - 7.4 microns long), first appearing on about the seventh proglottid; proglottids: immature, 0.055 - 0.148 x 0.225 - 0.675 mm, mature, 0.135 - 0.225 x 0.825 - 1.140 mm, gravid, not seen; genital pores unilateral; cirrus with a stylet about 260 microns long, cutinized in its posterior half, none seen everted; cirrus pouch, 195 - 204 microns long by 33 - 37 microns wide; testes 3, in a transverse row, 1 poral, 2 aporal, maximum size 0.285 mm in transverse diameter; ovary, maximum size, 0.060 mm in diameter; vitelline gland not clearly seen; eggs not seen.

30. Nadejdolepis sp. (Plate 8, Figures 23 - 26)

Cestodes identified to this genus were found on three occasions: an adult Aechmophorus occidentalis collected June 14, 1963 at Hastings Lake contained 25 cestodes; an adult Podiceps grisegena collected June 14, 1962 at Big Island Lake contained 25 cestodes; and an adult P. grisegena collected June

18, 1962 at Big Island Lake contained 25 cestodes.

These specimens appear to be a new species on the basis of hook and proglottid morphology, but a full description will await a more comprehensive survey of the literature.

Description: Length up to a maximum of about 8 mm; width increases slightly from the neck to a maximum of 0.330 - 0.375 mm; scolex, 0.210 - 0.225 x 0.240 - 0.255 mm, widest in the area of the suckers; rostellum, 0.255 - 0.259 x 0.041 - 0.044 mm expanded distally in the area on which the hooks are attached to 0.077 - 0.081 mm; rostellar sac, 0.444 - 0.451 x 0.077 - 0.081 at its widest which is at its base; suckers, 0.104 - 0.111 mm in diameter; hooks 10, from proximal end of handle to tip of blade, 40 - 44 microns, from proximal end of handle to tip of guard, 30 - 33 microns, from tip of guard to tip of blade, 11 - 13 microns; neck very short, 0.093 - 0.111 mm; proglottids: immature, 0.015 - 0.022 x 0.196 - 0.204 mm, mature, 0.026 - 0.033 x 0.215 - 0.270 mm, gravid, 0.033 - 0.037 x 0.278 - 0.281 mm; genital pores unilateral; cirrus, spined evenly along its length, 74 - 81 x 7 - 15 microns; cirrus pouch 0.111 - 0.185 x 0.019 - 0.022 mm, with an accessory sac; testes 3, one poral and two aporal, arranged in a transverse row or flat triangle, maximum diameter 0.052 mm; ovary a mass in the median posterior part of the proglottid with a transverse diameter of 0.062 - 0.081 mm; vitelline gland median reaching a maximum size of 0.041 mm in diameter; eggs thin shelled, 0.019 - 0.022 mm in diameter.

31. *Parafimbriaria websteri* Voge and Read, 1954

Type host: *Colymbus nigricollis* (= *Podiceps caspicus*).
Other recorded hosts: none.
Habitat: small intestine.
Life cycle: unknown.
Distribution. California.

Parafimbriaria websteri occurred in three of the grebe

species: Podiceps caspicus, P. auritus, and P. grisegena (Table XIX).

The specimens from Alberta grebes were similar in size and structure to those of Voge and Read, with the following exceptions: the scolex of Alberta forms was larger (240 - 255 microns versus 120 - 138 microns), larger suckers (75 - 90 microns versus 41 - 52 microns) and smaller hooks (24 - 26 microns versus 36 - 40 microns). These differences are not considered to justify the establishment of a new species because of the general agreement in the rest of the measurements and structures.

Parafimbriaria websteri was identified with the aid of the keys in Yamaguti (1959) and the description of Voge and Read (1954).

Family Amabiliidae

32. Schistotaenia colymba Schell, 1955 (Plate 9, Figures 27 and 28)

Type host: Colymbus auritus (= Podiceps auritus).

Other recorded hosts: none.

Habitat: duodenum.

Life cycle: unknown.

Distribution: Idaho.

Schistotaenia colymba was found in Podiceps caspicus and P. auritus (Table XX). Cestodes identified only as Schistotaenia sp. because of immaturity and loss of hooks are included in the table, as they agree in size and shape of scolex and suckers.

This parasite was identified by comparison with the original description.

Table XIX

Incidence of Parafimbriaria websteri in Three Species of Grebes in Alberta.

		Podiceps caspicus				Podiceps auritus			
		No. of birds examined	% infected	Av. no. of cestodes per bird	Range in no. of cestodes	No. of birds examined	% infected	Av. no. of cestodes per bird	Range in no. of cestodes
Adults									
April	16-30	10	20	8	1-14	-	-	-	-
May	1-15	10	30	4	1- 7	5	0	0	0
	16-31	11	55	5	1-15	5	0	0	0
June	1-15	13	8	2	2	7	14	14	14
	16-30	11	18	27	3-50	8	-	-	-
July	1-15	12	25	18	5-30	4	0	0	0
	16-31	13	0	0	0	8	13	3	3
Aug.	1-15	21	10	27	3-50	5	0	0	0
	16-31	-	-	-	-	-	-	-	-
Sept.	1-15	-	-	-	-	-	-	-	-
	16-30	-	-	-	-	1	0	0	0
Total		101	19	12	1-50	43	5	9	3-14
Immatures									
June	16-30	-	-	-	-	3	0	0	0
July	1-15	1	0	0	0	6	0	0	0
	16-31	15	7	1	1	6	0	0	0
Aug.	1-15	16	6	30	30	2	0	0	0
	16-31	10	20	14	3-25	9	11	4	4
Sept.	1-15	10	10	20	20	5	0	0	0
	16-30	10	20	3	2- 3	4	0	0	0
Oct.	1-15	-	-	-	-	1	0	0	0
	16-31	-	-	-	-	-	-	-	-
Nov.	1-15	1	0	0	0	-	-	-	-
Total		63	11	12	1-25	36	3	4	4

cont'd

Table XIX (cont'd)

	Podiceps grisegena			
	No. of brids examined	% infected	Av. no. of cestodes per bird	Range in no. of cestodes
Adults				
May 1-15	5	20	1	1
16-31	4	0	0	0
June 1-15	8	13	5	5
16-30	4	25	3	3
July 1-15	5	20	2	2
16-31	4	25	1	1
Aug. 1-15	-	-	-	-
16-31	-	-	-	-
Sept. 1-15	-	-	-	-
16-30	-	-	-	-
Total	30	17	2	1-5
Immatures				
June 1-15	1	0	0	0
16-30	8	0	0	0
July 1-15	14	0	0	0
16-31	4	0	0	0
Aug. 1-15	-	-	-	-
16-31	5	0	0	0
Sept. 1-15	1	0	0	0
Total	33	0	0	0

Table XX

Incidence of Schistotaenia colymba in Podiceps caspicus and P. auritus in Alberta.

		Podiceps caspicus				Podiceps auritus			
		No. of birds examined	% infected	Av. no. of cestodes per bird	Range in no. of cestodes	No. of birds examined	% infected	Av. no. of cestodes per bird	Range in no. of cestodes
Adults									
April	16-30	10	40	3	1- 7	-	-	-	-
May	1-15	10	40	8	2-10	5	40	59	3-115
	16-31	12	25	60	26-83	6	33	15	5- 25
June	1-15	14	36	8	1-29	7	29	8	1- 15
	16-30	11	27	15	5-32	8	13	4	4
July	1-15	12	33	9	1-16	5	20	10	10
	16-31	12	8	2	2	8	13	6	6
Aug.	1-15	21	48	5	1-17	5	0	0	0
	16-31	-	-	-	-	-	-	-	-
Sept.	1-15	-	-	-	-	-	-	-	-
	16-30	-	-	-	-	1	0	0	0
Total		102	33	11	1-83	45	22	27	1-115
Immatures									
June	16-30	-	-	-	-	3	0	0	0
July	1-15	1	0	0	0	7	0	0	0
	16-31	16	0	0	0	6	0	0	0
Aug.	1-15	16	13	1	1	2	0	0	0
	16-31	10	20	2	1- 2	9	33	43	1-125
Sept.	1-15	10	10	1	1	5	40	4	1- 6
	16-30	10	30	9	4-20	4	0	0	0
Oct.	1-15	-	-	-	-	1	100	2	2
	16-31	-	-	-	-	-	-	-	-
Nov.	1-15	1	100	1	1	-	-	-	-
Total		64	13	4	1-20	37	16	23	1-125

33. *Schistotaenia* sp. (Plate 10 and 11, Figures 31 - 35)

Podiceps grisegena is the most common host of this parasite with *P. auritus* also being quite heavily infected (Table XXI). *Podiceps caspicus* appears to be an accidental host.

This is thought to be a new species on the basis of hook measurements, number of testes and morphology of the strobila.

Description: Length, 6 - 12 mm; width, 2.5 - 3.5 mm excluding cirri, greatest 5 mm from anterior end; scolex, 0.68 - 0.90 mm long by 0.60 - 0.68 mm wide; rostellum, 330 - 405 microns long and 240 - 255 microns wide at its distal end, narrower proximally; rostellar sac, 555 - 690 microns long by 210 - 255 microns wide at its widest; suckers, 145 -225 microns in diameter, situated at the posterior and broadest part of the scolex; hooks, 23 - 24. length from proximal end of the handle to the tip of the blade, 67 - 69 microns, from the end of the handle to the end of the guard, 63 - 65 microns, from the end of the guard to the tip of the blade, 26 - 30 microns; genital pores alternate regularly; cirrus pouch, 165 - 180 microns by 450 - 480 microns; cirrus, 1.7 mm long by 60 - 75 microns wide, spined; seminal vesicle, 225 - 300 microns in diameter; testes, 13 aporal 12 poral, 60 - 70 microns in diameter; ovary, lobed, stretches completely across the segments; seminal receptacle 225 - 300 x 180 - 210 microns; vitelline gland is bilobed, 225 microns broad and 90 microns in diameter; eggs, 40 microns in diameter; oncospheres, 26 - 33 microns in diameter.

34. *Schistotaenia tenuicirrus* Chandler, 1948 (Plate 9, Figure 29 and 30)

Type host: *Podilymbus podiceps*.

Other recorded hosts: *Podiceps caspicus*, and *Corvus brachyrhynchos*.

Table XXI

Incidence of Schistotaenia sp. in Three Species of Grebes in Alberta.

		Podiceps caspicus				Podiceps auritus			
		No. of birds examined	% infected	Av. no. of cestodes per bird	Range in no. of cestodes	No. of birds examined	% infected	Av. no. of cestodes per bird	Range in no. of cestodes
Adults									
April	16-30	10	0	0	0	-	-	-	-
May	1-15	10	0	0	0	5	20	1	1
	16-31	12	0	0	0	5	20	2	2
June	1-15	14	14	2	1-2	7	43	16	1-45
	16-30	11	0	0	0	8	38	6	4-11
July	1-15	12	8	1	1	5	40	3	1- 4
	16-31	12	0	0	0	8	38	4	2- 6
Aug.	1-15	21	5	2	2	4	0	0	0
	16-31	-	-	-	-	-	-	-	-
Sept.	1-15	-	-	-	-	-	-	-	-
	16-30	-	-	-	-	1	0	0	0
Total		102	4	2	1-2	43	30	7	1-45
Immatures									
June	16-30	-	-	-	-	3	0	0	0
July	1-15	1	0	0	0	7	0	0	0
	16-31	16	0	0	0	6	0	0	0
Aug.	1-15	16	6	1	1	2	50	2	2
	16-31	10	0	0	0	9	22	2	1- 2
Sept.	1-15	10	0	0	0	5	40	41	6-75
	16-30	10	0	0	0	4	25	13	13
Oct.	1-15	-	-	-	-	-	-	-	-
	16-31	-	-	-	-	-	-	-	-
Nov.	1-15	1	0	0	0	-	-	-	-
Total		64	2	1	1	36	17	17	1-75

cont'd

Table XXI (cont'd)

		Podiceps grisegena			
		No. of birds examined	% infected	Av. no. of cestodes per bird	Range in no. of cestodes
Adults					
May	1-15	5	60	12	2-30
	16-31	5	40	4	1- 6
June	1-15	9	56	9	2-20
	16-30	6	83	9	1-24
July	1-15	5	100	6	1-13
	16-31	4	100	27	3-75
Total		34	71	11	1-75
Immatures					
June	1-15	1	0	0	0
	16-30	8	0	0	0
July	1-15	15	0	0	0
	16-31	4	0	0	0
Aug.	1-15	-	-	-	-
	16-31	5	80	11	1-40
Sept.	1-15	1	100	4	4
Total		34	15	9	1-40

Habitat: duodenum.

Life cycle: unknown.

Distribution: North America.

The infected immature _Podilymbus podiceps_ was collected on August 22, 1961. Another immature collected on this date and four more collected on July 23, 1962 were not infected. _Schistotaenia tenuicirrus_ is a normal parasite in _Podilymbus podiceps_ in other regions.

Schistotaenia tenuicirrus was identified with the aid of the key and description in Chandler (1948).

35. _Tatria biremis_ Kowalewski, 1904 (Plate 12, Figure 36 and 37)

Type host: _Podiceps auritus_.

Other recorded hosts: _P. nigricollis_ (= _P. caspicus_), and _P. grisegena_.

Habitat: small intestine.

Life cycle: unknown, however a related form (_Tatria acanthorhyncha_) has larvae in dragonfly nymphs (_Agrion_).

Distribution: Europe, Western Siberia.

In Alberta _Tatria biremis_ was found in _Podiceps caspicus_, _P. auritus_, and _P. grisegena_ (Table XXII).

Tatria biremis was identified with the aid of the keys and description of hooks in Olsen (1939).

Besides being found in the small intestine, stragglers have also been found in the caeca , rectum and oviduct (probably due to contamination during autopsy).

Table XXII

Incidence of Tatria biremis in Three Species of Grebes in Alberta.

		Podiceps caspicus				Podiceps auritus			
		No. of birds examined	% infected	Av. no. of cestodes per bird	Range in no. of cestodes	No. of birds examined	% infected	Av. no. of cestodes per bird	Range in no. of cestodes
Adults									
April	16-30	10	70	16	8- 35	-	-	-	-
May	1-15	10	40	208	25-400	7	100	209	50-875
	16-31	10	60	152	50-450	6	100	342	200-750
June	1-15	14	71	92	3-500	7	100	82	50-150
	16-30	11	91	46	10-200	8	75	32	10-100
July	1-15	12	92	98	20-300	4	75	175	25-450
	16-31	12	58	179	50-300	8	88	174	25-650
Aug.	1-15	21	76	181	50-350	5	40	83	40-125
	16-31	-	-	-	-	-	-	-	-
Sept.	1-15	-	-	-	-	-	-	-	-
	16-30	-	-	-	-	1	100	60	60
Total		100	71	119	3-500	46	85	160	10-875
Immatures									
June	16-30	-	-	-	-	3	0	0	0
July	1-15	1	0	0	0	6	17	2	2
	16-31	16	75	263	15-875	6	17	25	25
Aug.	1-15	16	69	239	50-450	2	100	225	200-250
	16-31	10	100	179	50-400	9	89	286	85-1500
Sept.	1-15	10	100	188	30-350	4	100	78	25-200
	16-30	10	100	223	115-400	4	100	151	75-275
Oct.	1-15	-	-	-	-	1	0	0	0
	16-31	-	-	-	-	-	-	-	-
Nov.	1-15	1	100	450	450	-	-	-	-
Total		64	84	224	15-875	35	57	184	2-1500

cont'd

Table XXII (cont'd)

	No. of birds examined	% infected	Av. no. of cestodes per bird	Range in no. of cestodes
	Podiceps grisegena			
Adults				
May 1-15	5	60	53	15-125
16-31	4	75	63	40- 75
June 1-15	6	50	59	2-150
16-30	6	83	28	1- 80
July 1-15	5	40	108	15-200
16-31	4	0	0	0
Aug. 1-15	-	-	-	-
Total	30	53	55	1-200
Immatures				
June 1-15	1	0	0	0
16-30	8	0	0	0
July 1-15	15	0	0	0
16-31	4	25	6	6
Aug. 1-15	-	-	-	-
16-31	5	40	45	15- 75
Sept. 1-15	1	100	25	25
Total	34	12	30	6- 75

36. _Tatria decacantha_ Fuhrmann, 1913 (Plate 12, Figure 38 and 39)

Type host: _Podiceps cristatus_.

Other recorded hosts: _P. ruficollis_, _P. nigricollis_ (= _P. caspicus_), and _Turdus migratorius_.

Habitat: small intestine.

Life cycle: larvae in nymphs of _Pseudothemis zonata_ and _Crocothemis servilia_ (dragonflies).

Distribution: Europe, Western Siberia, Mexico and Japan.

In Alberta this cestode was found in _Podiceps caspicus_, _P. auritus_, and _P. grisegena_ (Table XXIII).

Tatria decacantha was identified with the aid of keys in Olsen (1939) and Schultz (1940), and with the aid of the description of hooks in Olsen (1939).

Family Dioecocestidae

37. _Dioecocestus fuhrmanni_ Linton, 1925

Type host: _Colymbus hollboelli_ (= _Podiceps grisegena_).

Other recorded hosts: _Colymbus auritus_ (= _Podiceps auritus_).

Habitat: small intestine.

Life cycle: unknown, may involve aquatic crustaceans as related forms use them.

Distribution: Woods Hole, U.S.A.

Dioecocestus fuhrmanni was only found in _P. grisegena_ (Table XXIV).

An interesting fact in the biology of this dioecious tapeworm is that the male and female worms are usually found in

Table XXIII

Incidence of Tatria decacantha in Three Species of Grebes in Alberta

		Podiceps caspicus				Podiceps auritus			
		No. of birds examined	% infected	Av. no. of cestodes per bird	Range in no. of cestodes	No. of birds examined	% infected	Av. no. of cestodes per bird	Range in no. of cestodes
Adults									
April	16-30	10	40	29	5- 75	-	-	-	-
May	1-15	10	70	88	15-275	5	0	0	0
	16-31	10	60	73	2-300	6	17	50	50
June	1-15	14	29	44	1-100	7	0	0	0
	16-30	11	36	21	4- 50	8	13	13	13
July	1-15	12	42	17	4- 50	5	20	5	5
	16-31	12	50	58	25-200	8	13	25	25
Aug.	1-15	21	29	102	50-150	5	0	0	0
	16-31	-	-	-	-	-	-	-	-
Sept.	1-15	-	-	-	-	-	-	-	-
	16-30	-	-	-	-	1	0	0	0
Total		100	42	59	1-300	45	9	23	5-50
Immatures									
June	16-30	-	-	-	-	3	0	0	0
July	1-15	1	0	0	0	7	0	0	0
	16-31	16	25	22	1- 75	6	0	0	0
Aug.	1-15	16	19	117	50-200	3	33	10	10
	16-31	10	10	2	2	8	13	100	100
Sept.	1-15	10	0	0	0	4	0	0	0
	16-30	10	20	125	50-200	4	0	0	0
Oct.	1-15	-	-	-	-	1	0	0	0
	16-31	-	-	-	-	-	-	-	-
Nov.	1-15	1	0	0	0	-	-	-	-
Total		64	16	69	1-200	36	6	55	10-100

cont'd

Table XXIII (cont'd)

		Podiceps grisegena			
		No. of birds examined	% infected	Av. no. of cestodes per bird	Range in no. of cestodes
Adults					
May	1-15	5	60	42	25-100
	16-31	5	0	0	0
June	1-15	7	29	15	14- 15
	16-30	6	67	5	2- 7
July	1-15	5	0	0	0
	16-31	4	25	7	7
Aug.	1-15	-	-	-	-
Total		32	31	18	2-100
Immatures					
June	1-15	1	0	0	0
	16-30	8	0	0	0
July	1-15	15	0	0	0
	16-31	4	0	0	0
Aug.	1-15	-	-	-	-
	16-31	5	0	0	0
Sept.	1-15	1	100	5	5
Total		34	3	5	5

Table XXIV

Incidence of *Dioecocestus fuhrmanni* in *Podiceps grisegena*

		No. of birds examined	% infected	Av. no. of cestodes per bird	Range in no. of cestodes
Adults					
May	1-15	5	40	2	2
	16-31	6	33	2	1-2
June	1-15	8	25	2	1-2
	16-30	6	50	1	1-2
July	1-15	5	0	0	0
	16-31	4	25	2	2
Total		34	29	2	1-2
Immatures					
June	1-15	1	0	0	0
	16-30	8	0	0	0
July	1-15	15	7	1	1*
	16-31	4	50	1	1
Aug.	1-15	-	-	-	-
	16-31	5	40	3	3
Sept.	1-15	1	0	0	0
Total		34	15	2	1-3

* *Dioecocestus* sp. (immature)

pairs. On eight occasions mature male and female worms were found together, and on each of these occasions there was one mature male and female. On two occasions an immature female was found with the mature pair. Four mature females, one mature male, and one immature were found alone. The maximum size of the females was 47 cm and the males 40.5 cm. A population regulating mechanism may exist which prevents the establishment of more than one pair as these are large bulky cestodes that could injure the host if present in large numbers. The way in which this mechanism works is not known although the regulation is known to occur in another dioecious cestode Diploposthe laevis (Bloch, 1782) discussed in Jarecka (1960).

The immature Dioecocestus sp. (Plate 13, Figure 40) collected July 1, 1963 at Big Island Lake may be a new species, as the hooks are much larger than those of any described species (0.37 mm long as compared to 0.20 - 0.22 mm in Dioecocestus aspera (Mehlis, 1831) which has the largest hooks).

Dioecocestus fuhrmanni was identified with the aid of the descriptions in: Fuhrmann (1900), Fuhrmann (1904 a and b) Clerc (1907) and Linton (1925 and 1927).

Nematoda

Order Trichuridea

Family Trichuridae

38. Capillaria michiganensis Read, 1949 (Plate 14, Figures 41-43)

Type host: Ondatra zibethicus.

Other recorded hosts: none.

Habitat: small intestine.

Life cycle: unknown; however, other members of the genus have larval forms in earthworms or have direct life cycles.

Distribution: North America and Russia.

In this study *Capillaria michiganensis* was recovered from *Podiceps caspicus*, *P. auritus*, and *P. grisegena* (Table XXV). Some of the worms were found in the small intestine, but the majority were in the caeca.

Females were identified to *C. michiganensis* with the aid of the keys and description in Read (1949). As his description did not include a description of the male, this will be included here:

Body very slender, cuticle smooth. Esophageal portion slightly thinner than the posterior portion. Length 21.8 - 23.4 mm, width 55 - 60 microns.

Caudal end of the male provided with a very small bursal membrane supported by a pair of lateral papillae. Spicule long (2.2 - 2.3 mm), 7 - 9 microns wide surrounded by a transversely wrinkled sheath (19 - 22 microns wide) without spines. Proximal end of the spicule inflated ending in an open funnel. Spicule ends in a bluntly rounded tip, somewhat narrowed just before the end. Cloacal aperature terminal in the female but subterminal in the male.

The following species have spicules of somewhat similar lengths:

Capillaria spiculata Freitas, 1933 - 2.33 mm

Table XXV

Incidence of *Capillaria michiganensis* in Three Species of Grebes in Alberta.

		Podiceps caspicus				*Podiceps auritus*			
		No. of birds examined	% infected	Av. no. of nematodes per bird	Range in no. of nematodes	No. of birds examined	% infected	Av. no. of nematodes per bird	Range in no. of nematodes
Adults									
April	16-30	10	30	3	2- 3	-	-	-	-
May	1-15	10	10	13	13	5	0	0	0
	16-31	12	42	7	1-22	6	0	0	0
June	1-15	14	36	4	1- 8	7	0	0	0
	16-30	11	27	15	1-28	8	13	4	4
July	1-15	12	25	1	1- 2	5	20	74	74
	16-31	12	42	5	2-10	8	25	3	1- 4
Aug.	1-15	21	38	3	1-10	5	20	1	1
	16-31	-	-	-	-	-	-	-	-
Sept.	1-15	-	-	-	-	-	-	-	-
	16-30	-	-	-	-	1	0	0	0
Total		102	32	5	1-28	44	11	17	1-74
Immatures									
June	16-30	-	-	-	-	3	0	0	0
July	1-15	1	0	0	0	7	0	0	0
	16-31	16	0	0	0	6	0	0	0
Aug.	1-15	16	13	2	1- 3	2	0	0	0
	16-31	10	10	2	2	9	0	0	0
Sept.	1-15	10	0	0	0	5	0	0	0
	16-30	10	0	0	0	4	0	0	0
Oct.	1-15	-	-	-	-	1	0	0	0
	16-31	-	-	-	-	-	-	-	-
Nov.	1-15	1	0	0	0	-	-	-	-
Total		64	5	2	1- 3	37	0	0	0

cont'd

Table XXV (cont'd)

		Podiceps grisegena			
		No. of birds examined	% infected	Av. no. of nematodes per bird	Range in no. of nematodes
Adults					
May	1-15	5	75	9	1-28
	16-31	6	33	16	8-23
June	1-15	9	0	0	0
	16-30	6	33	6	6
July	1-15	5	40	2	1- 3
	16-31	4	50	7	4-10
Total		35	34	8	1-28
Immatures					
June	1-15	1	0	0	0
	16-30	8	0	0	0
July	1-15	15	0	0	0
	16-31	4	0	0	0
Aug.	1-15	-	-	-	-
	16-31	5	40	7	2-11
Sept.	1-15	1	0	0	0
Total		34	6	7	2-11

Capillaria longispicula (Sonsino, 1889) - 2 - 3.82 mm

C. gracilis (Bellingham, 1940) - 2.5 mm

C. felis-cati (Diesing, 1851) - 2.5 mm

C. longifilla (Dujardin, 1845) - 2 mm

C. heterodontis Harwood, 1932 - 2.55 - 3.25 mm

These can be eliminated because of total lengths of the worms. Capillaria felis-cati, and C. longispicula are longer; and C. spiculata and C. longifilla are much shorter. Capillaria gracilis is slightly shorter and is found in amphibians while C. heterodontis averages slightly less and is from reptiles. Also four of these species (Capillaria felis-cati, C. spiculata, C. gracilis and C. heterodontis) have spined spicule sheaths.

39. Capillaria pachyderma (Linstow, 1877)

Type host: Podiceps fluviatilis (= Podiceps ruficollis).

Other recorded hosts: Podiceps auritus.

Habitat: esophagus.

Life cycle: unknown; other capillarids have larvae in earthworms or have direct life cycles.

Distribution: Europe.

In this study Capillaria pachyderma was recovered from Podiceps caspicus, P. auritus and P. grisegena (Table XXVI). The occurrence only in adults and only from June to early August may indicate that this is a southern form with a long development.

Capillaria pachyderma was identified with the aid of the description in Lopez-Neyra (1947).

Table XXVI

Incidence of *Capillaria pachyderma* in Three Species of Grebes in Alberta.

		Podiceps caspicus				*Podiceps auritus*			
		No. of birds examined	% infected	Av. no. of nematodes per bird	Range in no. of nematodes	No. of birds examined	% infected	Av. no. of nematodes per bird	Range in no. of nematodes
Adults									
April	16-30	10	0	0	0	-	-	-	-
May	1-15	10	0	0	0	5	0	0	0
	16-31	12	0	0	0	6	0	0	0
June	1-15	14	14	1	1	7	0	0	0
	16-30	11	9	5	5	8	25	7	5-8
July	1-15	12	17	9	5-12	5	20	9	9
	16-31	12	25	5	3- 7	8	13	5	5
Aug.	1-15	20	20	1	1	5	0	0	0
Total		101	12	4	1-12	45	9	7	5-9
Immatures									
June	16-30	-	-	-	-	3	0	0	0
July	1-15	1	0	0	0	7	0	0	0
	16-31	16	0	0	0	6	0	0	0
Aug.	1-15	16	0	0	0	2	0	0	0
	16-31	10	0	0	0	9	0	0	0
Sept.	1-15	10	0	0	0	4	0	0	0
	16-30	10	0	0	0	4	0	0	0
Oct.	1-15	-	-	-	-	1	0	0	0
	16-31	-	-	-	-	-	-	-	-
Nov.	1-15	1	0	0	0	-	-	-	-
Total		64	0	0	0	36	0	0	0

Table XXVI (cont'd)

	Podiceps grisegena			
	No. of birds examined	% infected	Av. no. of nematodes per bird	Range in no. of nematodes
Adults				
April 16-30	-	-	-	-
May 1-15	5	0	0	0
16-31	6	0	0	0
June 1-15	8	0	0	0
16-30	6	17	1	1
July 1-15	5	0	0	0
16-31	4	0	0	0
Total	34	3	1	1
Immatures				
June 1-15	1	0	0	0
16-30	8	0	0	0
July 1-15	15	0	0	0
16-31	4	0	0	0
Aug. 1-15	-	-	-	-
16-31	5	0	0	0
Sept. 1-15	1	0	0	0
Total	34	0	0	0

Order Ascarididea

Family Heterocheilidae

40. *Contracaecum podicipitis* Johnston and Mawson, 1949

Type host: *Podiceps cristatus*.
Other recorded hosts: *Podilymbus podiceps*.
Habitat: small intestine.
Life cycle: unknown; however, other members of the genus have larval forms in fish.
Distribution: Australia and Canada.

It was found in *Podiceps caspicus*, *P. auritus*, and *P. grisegena* (Table XXVII) in Alberta.

This ascarid was compared with the description in Mawson (1956) and with descriptions of other forms in Cram (1927).

41. *Contracaecum* sp. (immature)

In many grebes, immature *Contracaecum* sp. (identifiable only to genus) were found under the lining of the gizzard, especially in the region of the pylorus (Table XXVIII). These may be an immature stage in the life cycle of *Contracaecum podicipitis*.

Order Spiruridea

Family Physalopteridae

42. *Streptocara crassicauda* (Creplin, 1829) Skrjabin, 1916.

Type host: *Colymbus rufogularis* (= *Gavia stellata*).
Other recorded hosts: species of the Gaviidae, Anatidae, and Alcidae.
Habitat: under the gizzard lining.
Life cycle: larvae in *Gammarus*.

Table XXVII

Incidence of <u>Contracaecum podicipitis</u> in Three Species of Grebes in Alberta.

		Podiceps caspicus				*Podiceps auritus*			
		No. of birds examined	% infected	Av. no. of nematodes per bird	Range in no. of nematodes	No. of birds examined	% infected	Av. no. of nematodes per bird	Range in no. of nematodes
Adults									
April	16-30	10	0	0	0	-	-	-	-
May	1-15	10	30	3	1- 5	5	40	3	2-3
	16-31	12	33	10	1-33	6	33	3	1-4
June	1-15	14	29	5	1- 7	7	29	3	2-4
	16-30	11	46	3	1- 5	8	25	2	1-3
July	1-15	12	42	8	1-20	5	40	4	1-7
	16-31	12	33	2	1- 4	8	13	1	1
Aug.	1-15	21	24	4	1- 6	5	0	0	0
	16-31	-	-	-	-	-	-	-	-
Sept.	1-15	-	-	-	-	-	-	-	-
	16-30	-	-	-	-	1	0	0	0
Total		102	29	5	1-33	45	24	3	1-7
Immatures									
June	16-30	-	-	-	-	3	0	0	0
July	1-15	1	100	1	1	7	43	3	2-3
	16-31	16	6	5	5	6	0	0	0
Aug.	1-15	16	31	6	1-13	2	0	0	0
	16-31	10	50	3	1- 7	9	11	1	1
Sept.	1-15	10	20	6	3- 8	4	0	0	0
	16-30	10	50	5	2- 8	4	25	1	1
Oct.	1-15	-	-	-	-	1	0	0	0
	16-31	-	-	-	-	-	-	-	-
Nov.	1-15	1	0	0	0	-	-	-	-
Total		64	31	5	1-13	36	14	2	1-3

cont'd

Table XXVII (cont'd)

		Podiceps grisegena			
		No. of birds examined	% infected	Av. no. of nematodes per bird	Range in no. of nematodes
Adults					
May	1-15	5	40	5	1- 8
	16-31	6	17	10	10
June	1-15	9	33	33	2-94
	16-30	6	50	1	1
July	1-15	5	60	3	1- 5
	16-31	4	75	2	1- 4
Total		35	43	9	1-94
Immatures					
June	1-15	1	0	0	0
	16-30	8	0	0	0
July	1-15	15	0	0	0
	16-31	4	25	2	2
Aug.	1-15	-	--	--	-
	16-31	5	20	4	4
Sept.	1-15	1	100	12	12
Total		34	9	6	2-12

Table XXVIII

Incidence of <u>Contracaecum</u> sp. (immature) in Five Species of Grebes in Alberta.

		Podiceps caspicus				*Podiceps auritus*			
		No. of birds examined	% infected	Av. no. of nematodes per bird	Range in no. of nematodes	No. of birds examined	% infected	Av. no. of nematodes per bird	Range in no. of nematodes
Adults									
April	16-30	10	0	0	0	-	-	-	-
May	1-15	10	20	8	7- 8	5	0	0	0
	16-31	12	33	7	1-15	6	17	1	1
June	1-15	14	21	2	1- 3	7	14	1	1
	16-30	11	9	1	1	8	0	0	0
July	1-15	12	0	0	0	5	20	3	3
	16-31	12	0	0	0	8	25	3	1-5
Aug.	1-15	21	14	2	1- 2	5	0	0	0
	16-31	-	-	-	-	-	-	-	-
Sept.	1-15	-	-	-	-	-	-	-	-
	16-30	-	-	-	-	1	0	0	0
Total		102	13	4	1-27	45	11	2	1-5
Immatures									
June	16-30	-	-	-	-	3	0	0	0
July	1-15	1	0	0	0	6	17	1	1
	16-31	16	0	0	0	6	0	0	0
Aug.	1-15	16	13	16	7-25	2	0	0	0
	16-31	10	10	16	16	9	0	0	0
Sept.	1-15	10	10	4	4	4	25	1	1
	16-30	10	10	24	24	4	0	0	0
Oct.	1-15	-	-	-	-	1	0	0	0
	16-31	-	-	-	-	-	-	-	-
Nov.	1-15	1	100	4	4	-	-	-	-
Total		64	9	13	4-32	35	6	2	1

cont'd

Table XXVIII (cont'd)

		Podiceps grisegena				Aechmophorus occidentalis			
		No. of birds examined	% infected	Av. no. of nematodes per bird	Range in no. of nematodes	No. of birds examined	% infected	Av. no. of nematodes per bird	Range in no. of nematodes
Adults									
May	1-15	5	0	0	0	1	0	0	0
	16-31	6	0	0	0	-	-	-	-
June	1-15	9	22	19	1-36	1	0	0	0
	16-30	6	0	0	0	4	0	0	0
July	1-15	5	0	0	0	-	-	-	-
	16-31	4	50	5	3- 7	-	-	-	-
Aug.	1-15	-	-	-	-	-	-	-	-
	16-31	-	-	-	-	-	-	-	-
Sept.	1-15	-	-	-	-	-	-	-	-
	16-30	-	-	-	-	-	-	-	-
Oct.	1-15	-	-	-	-	-	-	-	-
	16-31	-	-	-	-	1	100	5	5
Total		35	11	12	1-36	7	14	5	5
Immatures									
June	1-15	2	0	0	0	-	-	-	-
	16-30	8	0	0	0	7	0	0	0
July	1-15	15	0	0	0	-	-	-	-
	16-31	4	50	2	1- 3	-	-	-	-
Aug.	1-15	-	-	-	-	-	-	-	-
	16-31	5	20	5	5	-	-	-	-
Sept.	1-15	1	100	50	50	-	-	-	-
	16-30	-	-	-	-	-	-	-	-
Oct.	1-15	-	-	-	-	3	0	0	0
	16-31	-	-	-	-	2	50	39	39
Total		35	11	15	1-50	12	8	39	39
Podilymbus podiceps									
July	16-31	4	0	0	0				
Aug.	16-31	2	50	1	1				
Total		6	17	1	1				

Distribution: Europe, Russia, Formosa, and Eastern Siberia.

Streptocara crassicauda was found in Podiceps caspicus, P. auritus, P. grisegena and Aechmophorus occidentalis (Table XXIX).

A few specimens also occurred in the proventriculus; some were probably immature worms not yet settled under the gizzard lining, others were adults, due to contamination (with part of the gizzard being removed with the proventriculus) or due to postmortem migration.

Streptocara crassicauda was identified with the aid of the key and description in Cram (1927).

Family Acuariidae

43. Cosmocephalus firlottei Rao, 1951

Type host: Larus argentatus.
Other recorded hosts: none.
Habitat: esophagus.
Life cycle: unknown; an intermediate host is probably involved, as in other spirurids.
Distribution: Canada.

Cosmocephalus firlottei was found in Podiceps caspicus, P. auritus, P. grisegena and Aechmophorus occidentalis (Table XXX).

It was found primarily in the esophagus, but also in the trachea and proventriculus; the occurrence in the last two regions may be due to postmortem wandering, as the worms are very active when seen alive.

This nematode was identified with the aid of the key and description in Rao (1951).

Table XXIX

Incidence of Infection of Streptocara crassicauda in Four Species of Grebes in Alberta.

		Podiceps caspicus				Podiceps auritus			
		No. of birds examined	% infected	Av. no. of nematodes per bird	Range in no. of nematodes	No. of birds examined	% infected	Av. no. of nematodes per bird	Range in no. of nematodes
Adults									
April	16-30	10	40	4	1- 6	-	-	-	-
May	1-15	10	50	2	1- 6	5	40	3	2- 3
	16-31	12	33	2	1- 4	6	50	9	2-14
June	1-15	14	64	5	1-10	7	43	4	1- 6
	16-30	11	36	6	3-11	8	63	3	1- 6
July	1-15	12	58	5	2- 9	5	20	3	3
	16-31	12	92	13	1-25	8	25	2	1- 3
Aug.	1-15	21	86	13	1-40	5	40	3	1- 5
	16-31	-	-	-	-	-	-	-	-
Sept.	1-15	-	-	-	-	-	-	-	-
	16-30	-	-	-	-	1	0	0	0
Total		102	61	8	1-40	45	40	4	1-14
Immatures									
June	16-30	-	-	-	-	3	0	0	0
July	1-15	1	100	95	95	7	0	0	0
	16-31	16	69	18	1-66	6	0	0	0
Aug.	1-15	16	75	12	2-50	2	100	2	2
	16-31	10	90	7	1-22	9	100	11	1-27
Sept.	1-15	10	90	9	2-39	5	80	11	1-21
	16-30	10	90	7	2-17	4	75	6	1-14
Oct.	1-15	-	-	-	-	1	100	4	4
	16-31	-	-	-	-	-	-	-	-
Nov.	1-15	1	100	2	2	-	-	-	-
Total		64	81	12	1-95	37	51	9	1-27

cont'd

Table XXIX (cont'd)

		Podiceps grisegena				*Aechmophorus occidentalis*			
		No. of birds examined	% infected	Av. no. of nematodes per bird	Range in no. of nematodes	No. of birds examined	% infected	Av. no of nematodes per bird	Range in no. of nematodes
Adults									
May	1-15	5	60	16	10-21	1	0	0	0
	16-31	6	100	24	1-65	-	-	-	-
June	1-15	8	63	20	6-38	-	-	-	-
	16-30	6	83	30	20-48	4	0	0	0
July	1-15	5	100	25	4-52	-	-	-	-
	16-31	4	75	7	3-13	-	-	-	-
Aug.	1-15	-	-	-	-	-	-	-	-
	16-31	-	-	-	-	-	-	-	-
Sept.	1-15	-	-	-	-	-	-	-	-
	16-30	-	-	-	-	-	-	-	-
Oct.	1-15	-	-	-	-	-	-	-	-
	16-31	-	-	-	-	1	0	0	0
Total		34	80	22	1-65	7	0	0	0
Immatures									
June	1-15	2	0	0	0	-	-	-	-
	16-30	8	0	0	0	7	0	0	0
July	1-15	15	87	26	1-80	-	-	-	-
	16-31	4	100	15	1-27	-	-	-	-
Aug.	1-15	-	-	-	-	-	-	-	-
	16-31	5	100	14	1-30	-	-	-	-
Sept.	1-15	1	100	2	2	-	-	-	-
	16-30	-	-	-	-	-	-	-	-
Oct.	1-15	-	-	-	-	3	33	1	1
	16-31	-	-	-	-	2	50	1	1
Total		35	66	20	1-80	12	17	1	1

Table XXX

Incidence of Cosmocephalus firlottei in Four Species of Grebes in Alberta.

		Podiceps caspicus				Podiceps auritus			
		No. of birds examined	% infected	Av. no of nematodes per bird	Range in no. of nematodes	No. of birds examined	% infected	Av. no. of nematodes per bird	Range in no. of nematodes
Adults									
April	16-30	10	0	0	0	-	-	-	-
May	1-15	10	0	0	0	5	0	0	0
	16-31	12	8	2	2	6	0	0	0
June	1-15	14	14	1	1	7	14	2	2
	16-30	11	9	4	4	8	0	0	0
July	1-15	12	17	1	1	5	0	0	0
	16-31	12	33	2	1-3	8	0	0	0
Aug.	1-15	21	19	2	1-3	5	40	1	1
	16-31	-	-	-	-	-	-	-	-
Sept.	1-15	-	-	-	-	-	-	-	-
	16-30	-	-	-	-	1	0	0	0
Total		102	14	2	1-4	45	7	1	1-2
Immatures									
June	16-30	-	-	-	-	3	0	0	0
July	1-15	1	100	2	2	7	0	0	0
	16-31	16	31	10	3-19	6	0	0	0
Aug.	1-15	16	50	4	1- 9	2	0	0	0
	16-31	10	20	12	6-19	9	22	2	2
Sept.	1-15	10	20	2	2	4	50	2	1-2
	16-30	10	50	2	1- 5	4	0	0	0
Oct.	1-15	-	-	-	-	1	0	0	0
	16-31	-	-	-	-	-	-	-	-
Nov.	1-15	1	0	0	0	-	-	-	-
Total		64	36	6	1-19	36	11	2	1-2

cont'd

Table XXX (cont'd)

		Podiceps grisegena				*Aechmophorus occidentalis*			
		No. of birds examined	% infected	Av. no. of nematodes per bird	Range in no. of nematodes	No. of birds examined	% infected	Av. no. of nematodes per bird	Range in no. of nematodes
Adults									
May	1-15	5	0	0	0	1	0	0	0
	16-31	6	17	10	10	-	-	-	-
June	1-15	8	13	6	6	1	0	0	0
	16-30	6	67	2	1- 4	3	67	2	1-2
July	1-15	5	60	1	1- 2	-	-	-	-
	16-31	4	50	6	1-10	-	-	-	-
Aug.	1-15	-	-	-	-	-	-	-	-
	16-31	-	-	-	-	-	-	-	-
Sept.	1-15	-	-	-	-	-	-	-	-
	16-30	-	-	-	-	-	-	-	-
Oct.	1-15	-	-	-	-	3	0	0	0
	16-31	-	-	-	-	1	0	0	0
Total		34	32	4	1-10	9	33	1	1-2
Immatures									
June	1-15	1	0	0	0	-	-	-	-
	16-30	8	0	0	0	8	0	0	0
July	1-15	15	20	4	2- 6	-	-	-	-
	16-31	4	50	4	1- 6	-	-	-	-
Aug.	1-15	-	-	-	-	-	-	-	-
	16-31	5	60	3	2- 3	-	-	-	-
Sept.	1-15	1	0	0	0	-	-	-	-
	16-30	-	-	-	-	-	-	-	-
Oct.	1-15	-	-	-	-	3	0	0	0
	16-31	-	-	-	-	2	100	2	1-2
Total		34	24	3	1- 6	13	15	2	1-2

44. Dispharynx sp. (immature)

Immature nematodes belonging to this genus were recovered twice from the esophagus of adult Podiceps caspicus (July 5, 1962 from Big Island Lake and August 13, 1962 from CPR Reservoir). Members of this genus have been reported from species of the Accipitridae, Tetraonidae, Columbidae, Passeriformes, Pelecanidae, etc. None have been reported from grebes.

45. Echinuria decorata Cram, 1927

Type host: Colymbus auritus (= Podiceps auritus).
Other recorded hosts: Podiceps ruficollis, P. cristatus, and Podiceps sp.
Habitat: under the horny lining of the gizzard.
Life cycle: unknown; however, Echinuria uncinata (Rudolphi, 1819) has larval forms in Daphnia.
Distribution: North America, England, and Russia.

Echinuria decorata was found in Podiceps caspicus, P. auritus, P. grisegena, and Aechmophorus occidentalis (Table XXXI).

Although most of the worms were found in the typical habitat, some were found in the proventriculus, probably due to contamination from the gizzard.

Echinuria decorata was identified with the aid of the keys and description in Cram (1927).

Family Tropisuridae

46. Tropisurus fissispinus (Diesing, 1861) Neumann, 1888

Type host: Anas boschas.
Other recorded hosts: Podiceps fluviatilis (= Podiceps ruficollis), species of the Anatidae, Gruidae

Table XXXI

Incidence of Echinuria decorata in Four Species of Grebes in Alberta.

		Podiceps caspicus				Podiceps auritus			
		No. of birds examined	% infected	Av. no. of nematodes per bird	Range in no. of nematodes	No. of birds examined	% infected	Av. no. of nematodes per bird	Range in no. of nematodes
Adults									
April	16-30	10	60	5	1-14	-	-	-	-
May	1-15	10	70	3	1- 8	5	80	16	1-40
	16-31	12	67	4	1- 8	6	67	7	1- 9
June	1-15	14	57	4	1- 7	7	43	11	1-26
	16-30	11	46	3	1- 5	8	63	2	1- 4
July	1-15	12	58	3	1- 7	5	80	2	1- 3
	16-31	12	0	0	0	8	75	3	1- 4
Aug.	1-15	21	38	2	1- 5	5	20	2	2
	16-31	-	-	-	-	-	-	-	-
Sept.	1-15	-	-	-	-	-	-	-	-
	16-30	-	-	-	-	1	100	1	1
Total		102	48	3	1- 8	45	62	5	1-40
Immatures									
June	16-30	-	-	-	-	3	0	0	0
July	1-15	1	0	0	0	6	0	0	0
	16-31	16	19	13	2-33	6	0	0	0
Aug.	1-15	16	13	3	2- 4	2	0	0	0
	16-31	10	20	3	2- 3	9	0	0	0
Sept.	1-15	10	30	2	1- 3	5	0	0	0
	16-30	10	30	3	1- 4	4	0	0	0
Oct.	1-15	-	-	-	-	1	0	0	0
	16-31	-	-	-	-	-	-	-	-
Nov.	1-15	1	0	0	0	-	-	-	-
Total		64	20	5	1-33	36	0	0	0

cont'd

Table XXXI (cont'd)

		Podiceps grisegena				Aechmophorus occidentalis			
		No. of birds examined	% infected	Av. no. of nematodes per bird	Range in no. of nematodes	No. of birds examined	% infected	Av. no. of nematodes per bird	Range in no. of nematodes
Adults									
May	1-15	5	100	9	2-18	1	0	0	0
	16-31	6	50	6	2-10	-	-	-	-
June	1-15	8	13	2	2	1	100	1	1
	16-30	6	17	3	3	4	0	0	0
July	1-15	5	0	0	0	-	-	-	-
	16-31	4	0	0	0	-	-	-	-
Aug.	1-15	-	-	-	-	-	-	-	-
	16-31	-	-	-	-	-	-	-	-
Sept.	1-15	-	-	-	-	-	-	-	-
	16-30	-	-	-	-	-	-	-	-
Oct.	1-15	-	-	-	-	-	-	-	-
	16-31	-	-	-	-	1	0	0	0
Total		34	29	7	2-18	7	14	1	1
Immatures									
June	1-15	2	0	0	0	-	-	-	-
	16-30	8	0	0	0	7	0	0	0
July	1-15	15	0	0	0	-	-	-	-
	16-31	4	0	0	0	-	-	-	-
Aug.	1-15	-	-	-	-	-	-	-	-
	16-31	5	0	0	0	-	-	-	-
Sept.	1-15	1	0	0	0	-	-	-	-
	16-30	-	-	-	-	-	-	-	-
Oct.	1-15	-	-	-	-	3	0	0	0
	16-31	-	-	-	-	2	0	0	0
Total		35	0	0	0	12	0	0	0

and Columbidae.

Habitat: females in glands of the proventriculus, males in the lumen being lost fairly quickly.

Life cycle: intermediate hosts are *Daphnia* and *Gammarus*.

Distribution: cosmopolitan.

Tropisurus fissispinus was found in *Podiceps caspicus*, *P. auritus*, *P. grisegena*, and *Aechmophorus occidentalis* (Table XXXII). Also included in this table are two specimens identified only as *Tropisurus* sp., because one was destroyed (from *Podiceps caspicus* collected July 17, 1963 at Cooking Lake) and one was encysted and nearly disintegrated (from *P. caspicus* collected August 7, 1962 at CPR Reservoir). Because no other species of *Tropisurus* were found these are included with *T. fissispinus*.

This nematode was identified with the aid of the keys and description in Cram (1927).

Order Filariidea

Family Filariidae

47. *Spirofilaria fulicae-atrae* (Diesing, 1861) Yamaguti, 1961

Type host: *Fulica atra*.

Other recorded hosts: *Podiceps ruficollis ruficollis* and *P. ruficollis japonicus*.

Habitat: connective tissue.

Life cycle: unknown.

Distribution: Europe and Japan.

Table XXXIII indicates the intensity and extensity of the seasonal infections of this nematode. It is interesting to note that none of the immatures were infected. This may be

Table XXXII

Incidence of Tropisurus fissispinus in Four Species of Grebes in Alberta.

		Podiceps caspicus				Podiceps auritus			
		No. of birds examined	% infected	Av. no. of nematodes per bird	Range in no. of nematodes	No. of birds examined	% infected	Av. no. of nematodes per bird	Range in no. of nematodes
Adults									
April	16-30	10	10	3	3	-	-	-	-
May	1-15	10	20	2	1-2	5	40	8	5-10
	16-31	12	8	3	3	6	0	0	0
June	1-15	14	7	3	3	7	0	0	0
	16-30	11	0	0	0	8	75	4	1- 8
July	1-15	12	8	1	1	5	20	3	3
	16-31	11	0	0	0	8	25	16	3-20
Aug.	1-15	20	10	1	1	5	40	2	1- 2
	16-31	-	-	-	-	-	-	-	-
Sept.	1-15	-	-	-	-	-	-	-	-
	16-30	-	-	-	-	1	0	0	0
Total		100	8	2	1-3	45	29	6	1-20
Immatures									
June	16-30	-	-	-	-	3	0	0	0
July	1-15	1	0	0	0	7	0	0	0
	16-31	16	0	0	0	6	0	0	0
Aug.	1-15	16	0	0	0	2	0	0	0
	16-31	10	0	0	0	9	0	0	0
Sept.	1-15	10	0	0	0	4	25	8	8
	16-30	10	0	0	0	4	0	0	0
Oct.	1-15	-	-	-	-	1	0	0	0
	16-31	-	-	-	-	-	-	-	-
Nov.	1-15	1	0	0	0	-	-	-	-
Total		64	0	0	0	36	3	8	8

cont'd

Table XXXII (cont'd)

	Podiceps grisegena				*Aechmophorus occidentalis*			
	No. of birds examined	% infected	Av. no. of nematodes per bird	Range in no. of nematodes	No. of birds examined	% infected	Av. no. of nematodes per bird	Range in no. of nematodes
Adults								
May 1-15	5	0	0	0	1	0	0	0
16-31	6	0	0	0	-	-	-	-
June 1-15	8	0	0	0	1	0	0	0
16-30	6	17	1	1	4	25	1	1
July 1-15	5	0	0	0	-	-	-	-
16-31	4	0	0	0	-	-	-	-
Aug. 1-15	-	-	-	-	-	-	-	-
16-31	-	-	-	-	-	-	-	-
Sept. 1-15	-	-	-	-	-	-	-	-
16-30	-	-	-	-	-	-	-	-
Oct. 1-15	-	-	-	-	-	-	-	-
16-31	-	-	-	-	1	0	0	0
Total	34	3	1	1	7	14	1	1
Immatures								
June 1-15	1	0	0	0	-	-	-	-
16-30	8	0	0	0	7	0	0	0
July 1-15	15	0	0	0	-	-	-	-
16-31	4	0	0	0	-	-	-	-
Aug. 1-15	-	-	-	-	-	-	-	-
16-31	5	0	0	0	-	-	-	-
Sept. 1-15	1	0	0	0	-	-	-	-
16-30	-	-	-	-	-	-	-	-
Oct. 1-15	-	-	-	-	3	0	0	0
16-31	-	-	-	-	2	0	0	0
Total	34	0	0	0	12	0	0	0

Table XXXIII

Incidence of Spirofilaria fulicae-atrae in Three Species of Grebes in Alberta.

		Podiceps caspicus				Podiceps auritus			
		No. of birds examined	% infected	Av. no. of nematodes per bird	Range in no. of nematodes	No. of birds examined	% infected	Av. no. of nematodes per bird	Range in no. of nematodes
Adults									
April	16-30	10	40	6	1-11	-	-	-	-
May	1-15	10	20	6	2-10	4	0	0	0
	16-31	10	20	6	1-10	3	0	0	0
June	1-15	14	29	2	1- 3	6	17	3	3
	16-30	9	0	0	0	8	13	7	7
July	1-15	12	8	6	6	4	25	34	34
	16-31	12	33	10	1-27	8	0	0	0
Aug.	1-15	21	9	6	5- 7	5	0	0	0
	16-31	-	-	-	-	-	-	-	-
Sept.	1-15	-	-	-	-	-	-	-	-
	16-30	-	-	-	-	1	0	0	0
Total		98	11	6	1-27	39	8	15	3-34
Immatures									
June	16-30	-	-	-	-	3	0	0	0
July	1-15	1	0	0	0	4	0	0	0
	16-31	16	0	0	0	6	0	0	0
Aug.	1-15	16	0	0	0	2	0	0	0
	16-31	10	0	0	0	5	0	0	0
Sept.	1-15	10	0	0	0	4	0	0	0
	16-30	10	0	0	0	4	0	0	0
Oct.	1-15	-	-	-	-	-	-	-	-
	16-31	-	-	-	-	-	-	-	-
Nov.	1-15	1	0	0	0	-	-	-	-
Total		64	0	0	0	28	0	0	0

cont'd

Table XXXIII (cont'd)

		Podiceps grisegena			
		No. of birds examined	% infected	Av. no. of nematodes per bird	Range in no. of nematodes
Adults					
May	1-15	5	40	81	30-132
	16-31	4	50	30	1- 58
June	1-15	5	40	10	1- 19
	16-30	6	17	12	12
July	1-15	5	40	120	6-234
	16-31	5	60	10	4- 19
Aug.	1-15	-	-	-	-
Total		30	40	44	1-234
Immatures					
June	1-15	1	0	0	0
	16-30	8	0	0	0
July	1-15	15	0	0	0
	16-31	4	0	0	0
Aug.	1-15	-	-	-	-
	16-31	5	0	0	0
Sept.	1-15	1	0	0	0
Total		34	0	0	0

due to a long prepatent period or to transmission only on the wintering grounds.

These filarids were found only in lymph or caseous pockets among the tendons and between the bone and skin of the lower leg of grebes (in the area of the tarsal joint).

Spirofilaria fulicae-atrae was identified with the aid of the keys and descriptions in Yamaguti (1961) and the description in Yamaguti (1941). I agree with Baylis (1944) who synonymized S. podicipitis Yamaguti (1941) with S. fulicae-atrae. Evidence against this synonomy is slight (difference in distance of the caudal papillae from the posterior end - 0.1 mm in S. fulicae-atrae and 0.4 mm in S. podicipitis). This is a very difficult measurement to make because the posterior end of the male is coiled and Yamaguti had only one male which he indicated may be immature and in which he could not even be sure of the number of caudal papillae. Also Yamaguti had no reference to S. fulicae-atrae, he indicated S. podicipitis was closest in resemblence to a reptilian parasite Saurositus Macfie (1924).

Acanthocephala

Order Echinorhynchidea

Family Polymorphidae

48. Polymorphus paradoxus Connell and Corner, 1957

Type host: Castor canadensis.

Other recorded hosts: Ondatra zibethica, and Fulica americana (development never reaching maturity).

Habitat: jejunum and ileum.

Life cycle: cystacanths are encysted in the haemocoel of *Gammarus* (Connell and Corner, 1957).

Distribution: Alberta.

Polymorphus paradoxus was found in *Podiceps caspicus*, *P. auritus*, *P. grisegena*, and *Aechmophorus occidentalis* (Table XXXIV).

Connell and Corner searched for other hosts of this parasite but after examining several species of water birds found only coots to be infected, and only with immature worms. No grebes were examined. The occurrence of this parasite in both birds and mammals is quite unusual for this genus which is typical of birds.

In grebes the worms occurred in the lower small intestine and the upper large intestine. Also, many encysted forms were found in the gizzard if the bird had been feeding on *Gammarus*.

Polymorphus paradoxus was identified with the aid of the description in Connell and Corner (1957). Also comparisons were made with worms from muskrats identified by J. C. Holmes as *P. paradoxus*.

Hirudinea

Order Rhynchobdellida

Family Glossiphoniidae

49. *Theromyzon rude* (Baird, 1863)

Type host: none.

Other recorded hosts: aquatic birds.

Table XXXIV

Incidence of Polymorphus paradoxus in Four Species of Grebes in Alberta.

		Podiceps caspicus				Podiceps auritus			
		No. of birds examined	% infected	Av. no. of worms per bird	Range in no. of worms.	No. of birds examined	% infected	Av. no. of worms per bird	Range in no. of worms.
Adults									
April	16-30	10	10	14	14	-	-	-	-
May	1-15	10	0	0	0	5	0	0	0
	16-31	12	17	63	14-112	6	0	0	0
June	1-15	14	0	0	0	7	0	0	0
	16-30	11	0	0	0	8	13	13	13
July	1-15	12	0	0	0	5	0	0	0
	16-31	12	0	0	0	8	0	0	0
Aug.	1-15	21	10	3	2- 4	5	0	0	0
	16-31	-	-	-	-	-	-	-	-
Sept.	1-15	-	-	-	-	-	-	-	-
	16-30	-	-	-	-	1	0	0	0
Total		102	8	18	1-112	45	2	13	13
Immatures									
June	16-30	-	-	-	-	3	0	0	0
July	1-15	1	0	0	0	7	0	0	0
	16-31	16	0	0	0	6	0	0	0
Aug.	1-15	16	6	11	11	2	0	0	0
	16-31	10	10	1	1	9	11	1	1
Sept.	1-15	10	0	0	0	5	0	0	0
	16-30	10	20	15	2- 27	4	0	0	0
Oct.	1-15	-	-	-	-	1	0	0	0
	16-31	-	-	-	-	-	-	-	-
Nov.	1-15	1	0	0	0	-	-	-	-
Total		64	6	10	1- 27	37	3	1	1

cont'd

Table XXXIV (cont'd)

		Podiceps grisegena				*Aechmophorus occidentalis*			
		No. of birds examined	% infected	Av. no. of worms per bird	Range in no. of worms.	No. of birds examined	% infected	Av. no. of worms per bird	Range in no. of worms.
Adults									
May	1-15	5	60	9	4-12	1	0	0	0
	16-31	5	40	28	11-44	-	-	-	-
June	1-15	10	50	34	1-64	3	33	40	40
	16-30	6	67	29	2-96	4	0	0	0
July	1-15	5	100	27	3-72	-	-	-	-
	16-31	4	50	49	16-81	-	-	-	-
Aug.	1-15	-	-	-	-	-	-	-	-
	16-31	-	-	-	-	-	-	-	-
Sept.	1-15	-	-	-	-	-	-	-	-
	16-30	-	-	-	-	-	-	-	-
Oct.	1-15	-	-	-	-	-	-	-	-
	16-31	-	-	-	-	1	0	0	0
Total		35	63	29	1-96	9	11	40	40
Immatures									
June	1-15	1	0	0	0	-	-	-	-
	16-30	8	0	0	0	7	0	0	0
July	1-15	15	0	0	0	-	-	-	-
	16-31	4	0	0	0	-	-	-	-
Aug.	1-15	-	-	-	-	-	-	-	-
	16-31	5	40	5	1- 8	-	-	-	-
Sept.	1-15	1	0	0	0	-	-	-	-
	16-30	-	-	-	-	1	0	0	0
Oct.	1-15	-	-	-	-	5	0	0	0
	16-31	-	-	-	-	2	0	0	0
Total		34	6	5	1- 8	15	0	0	0

Habitat: nasal cavity.

Life cycle: direct.

Distribution: North America.

Theromyzon rude was found in each of the five species of grebes in the nasal cavity (where it feeds on the mucous membrane) and once in the lungs (a partially destroyed specimen).

These leeches were identified by J. E. Moore. Although on several occasions they could not be identified to species because of their engorged condition, all of the leeches are included in Table XXXV.

Table XXXV

Incidence of Theromyzon rude and Theromyzon sp. in Five Species of Grebes in Alberta.

		Podiceps caspicus				Podiceps auritus			
		No. of birds examined	% infected	Av. no. of leeches per bird	Range in no. of leeches.	No. of birds examined	% infected	Av. no. of leeches per bird	Range in no. of leeches.
Adults									
April	16-30	10	10	1	1	-	-	-	-
May	1-15	10	10	1	1	4	25	1	1
	16-31	10	20	1	1	3	0	0	0
June	1-15	14	7	1	1	6	67	1	1
	16-30	11	0	0	0	8	0	0	0
July	1-15	12	8	1	1	4	25	2	2
	16-31	12	25	2	1-3	8	0	0	0
Aug.	1-15	21	14	1	1-2	5	20	2	2
	16-31	-	-	-	-	-	-	-	-
Sept.	1-15	-	-	-	-	-	-	-	-
	16-30	-	-	-	-	1	0	0	0
Total		100	12	1	1-3	39	18	1	1-2
Immatures									
June	16-30	-	-	-	-	3	0	0	0
July	1-15	1	0	0	0	4	25	1	1
	16-31	16	13	1	1	6	0	0	0
Aug.	1-15	16	13	11	9-13	2	0	0	0
	16-31	10	10	1	1	9	0	0	0
Sept.	1-15	10	0	0	0	4	0	0	0
	16-30	10	20	1	1	4	0	0	0
Oct.	1-15	-	-	-	0	1	0	0	0
	16-31	-	-	-	-	-	-	-	-
Nov.	1-15	1	0	0	0	-	-	-	-
Total		64	11	4	1-13	33	3	1	1

cont'd

Table XXXV (cont'd)

	Podiceps grisegena				Aechmophorus occidentalis			
	No. of birds examined	% infected	Av. no. of leeches per bird	Range in no. of leeches.	No. of birds examined	% infected	Av. no. of leeches per bird	Range in no. of leeches.
Adults								
May 1-15	5	0	0	0	1	0	0	0
16-31	4	25	2	2	-	-	-	-
June 1-15	6	17	1	1	1	0	0	0
16-30	6	17	2	2	4	50	11	1-20
July 1-15	5	40	4	3-5	-	-	-	-
16-31	4	25	12	12	-	-	-	-
Aug. 1-15	-	-	-	-	-	-	-	-
16-31	-	-	-	-	-	-	-	-
Sept. 1-15	-	-	-	-	-	-	-	-
16-30	-	-	-	-	-	-	-	-
Oct. 1-15	-	-	-	-	-	-	-	-
16-31	-	-	-	-	1	0	0	0
Total	30	20	4	1-12	7	29	11	1-20
Immatures								
June 16-30	7	14	2	2	7	0	0	0
July 1-15	15	13	1	1	-	-	-	-
16-31	4	25	1	1	-	-	-	-
Aug. 1-15	-	-	-	-	-	-	-	-
16-31	5	0	0	0	-	-	-	-
Sept. 1-15	1	0	0	0	-	-	-	-
16-30	-	-	-	-	-	-	-	-
Oct. 1-15	-	-	-	-	3	0	0	0
16-31	-	-	-	-	2	0	0	0
Total	32	13	1	1-2	12	0	0	0
Podilymbus podiceps								
July 16-31	4	25	2	2				
Aug. 16-31	2	50	2	2				
Total	6	33	2	2				

Specificity of Helminths of Grebes.

A noteworthy attribute of parasitism is the limitation of a parasite to one or few hosts. This specificity of the parasite fauna is often used to trace phylogenetic and ecologic relationships (for example, Rothschild and Clay, 1952).

The most used but least accurate method for illustrating specificity is the listing of hosts and their parasites. More accurate methods were devised by Michajłow (1959) and Sulgostowska (1958), who constructed classifications of host-parasite relationships. Whereas Michajłow's classification was based mainly on experimental work Sulgostowska's was based on ecological studies. A third system, presented here, is an expansion of Sulgostowska's to include two new categories-the accidental and the inhibitory hosts. It is based on more complete field studies of one group of birds. Michajłow's system is not equivalent to the ecological system.

Michajłow's (1959) classification includes five categories:

I. A relationship in which no development takes place in the host; parasites are not infective to that host.

II. (Spurious system) is one in which there is ".... faint extensity and intensity of invasion, development completely inhibited ....."

III. (accidental system) is one in which the parasite occurs in ".... small extensity and intensity of invasion and mostly of an inhibited development ....."

IV. (Auxiliary system) is one of small extensity and intensity of invasion but normal course of development.

V. (Proper system) ".... is characterized by maximal extensity and intensity (....) and by normal course of

development of the parasite," (Michajłow, 1959).

Michajłow attempted to infect a variety of hosts with certain parasites. In a discussion of the factors involved in this relationship, he considers the environmental ones (geographical, phenological, and ecological) to be very complex but ignores them in the formation of host - parasite categories. From the ecological standpoint it is impossible to place parasites into Michajłow's categories I, II, or III without examination of a very large number of hosts. Parasites can be placed in Michajłow's categories I, II, and III only through the experimental approach.

Sulgostowska's classification divides hosts into main (highly probable) and auxiliary hosts, using intensity and extensity data. She neglects hosts that fit into Michajłow's categories I, II, and III. Sulgostowska's auxiliary host may include Michajłow's II, III, and IV, but to try to equate these two systems is impossible as they are based on different approaches, the experimental and the observational.

Because Sulgostowska's categorization was rather simple it was thought that a more elucidative system could be arrived at. Sulgostowska's classification was expanded to include two new categories, the accidental and inhibitory hosts. So the new classification would include:

Main host: hosts in which the intensity and extensity of occurrence is relatively the highest.

Auxiliary host: hosts invaded less frequently and by a smaller number of helminths.

Accidental host: hosts invaded by very few helminths on rare occasions. This category is a subdivision of Sulgostowska's auxiliary host category.

Inhibitory hosts: hosts in which the helminths do not mature; most of the parasites in this category would be in Michajłow's categories II and III.

The experimental and ecological approaches are not equatable because the experimental approach is based on conditions from which the ecological influences have been removed; that is, effects which would serve to limit the infection of the host, such as preferences for food items other than the infected intermediate hosts and ecological isolation of infected intermediate hosts and definite hosts. Hence experimental infections may not mean that the host will be infected under natural conditions.

I have attempted to divide the helminths found in grebes in Alberta into the four categories (Table XXXVI). Because the limits of the groups are arbitrary, a discussion of borderline cases is included. In most cases the relationships indicated in this table are tentative pending data on the parasitism of other hosts.

Categorization of a given host-parasite relationship involves a consideration of extensity and intensity of infection, phenology of infection, and occurrence and phenology in other hosts.

The main host category was used on 28 occasions. Some knowledge of the occurrences of the helminths in other hosts

Table XXXVI

Categorization of Host-Parasite Relationships in Five Species of Grebes in Alberta.

Helminth	Podiceps caspicus	Podiceps auritus	Podiceps grisegena	Aechmophorus occidentalis	Podilymbus podiceps
Trematoda					
Cotylurus erraticus	-	Aux.	Aux.	Aux.	-
Cotylurus pileatus	-	-	-	Aux?	-
Cotylurus platycephalus	Aux.	Aux.	-	Aux.	-
Apatemon gracilis	Aux.	Aux.	Main	Aux.	-
Tylodelphys podicipina	-	-	Aux.	Main	-
Dendritobilharzia anatinarum	Acc?	-	-	-	-
Echinostoma revolutum	Aux.	Aux.	Aux.	-	-
Petasiger nitidus	Aux.	Aux.	Main	Aux.	Main?
Echinochasmus donaldsoni	Aux.	-	-	Aux.	-
Stephanoprora pseudoechinata	Aux.	-	-	-	-
Ribeiroia thomasi	-	Aux.	Aux.	Aux.	Aux.
Notocotylus attenuatus	Acc.	-	Acc.	-	-
Eucotyle cohni	Aux.	Main	Aux.	-	-
Maritrema japonicum	Acc.	-	Acc.	-	-
Plagiorchis maculosus	-	-	Acc.	-	Acc.
Galactosomum humbargari	-	-	Acc.	-	-
Orchipedum tracheicola	Inhib.	Inhib.	Inhib.	-	-
Cestoda					
Ligula intestinalis	Aux.	Aux.	Aux.	Main	-
Schistocephalus solidus	Aux.	Aux.	Aux.	Aux.	-
Tetrabothrius immerinus	-	Aux.	Aux.	-	-
Lateriporus sp.	-	-	Main?	-	-
Lateriporus sp. (immature)	Inhib.	-	Inhib.	-	-
Dicranotaenia sp.	-	-	-	Main	-
Diorchis sp.	Main	-	Aux.	-	-
Dubininolepis furcifera	Aux.	Main	Aux.	Aux.	?
Dubininolepis podicipina	Main	-	-	-	-
Hymenosphenacanthus sp. #1	-	-	Main	-	-
Hymenosphenacanthus sp. #2	Main	-	Aux.	-	-
Nadejdolepis sp.	-	-	Main	Aux.	-
Parafimbriaria websteri	Main	Aux.	Aux.	-	-
Schistotaenia colymba	Main	Aux.	-	-	-
Schistotaenia sp.	Aux.	Aux.	Main	-	-
Schistotaenia tenuicirrus	-	-	-	-	Main
Tatria biremis	Main	Aux.	Aux.	-	-
Tatria decacantha	Main	Aux.	Aux.	-	-
Dioecocestus fuhrmanni	-	-	Main	-	-

cont'd

Table XXXVI (cont'd)

Helminth	Podiceps caspicus	Podiceps auritus	Podiceps grisegena	Aechmophorus occidentalis	Podilymbus podiceps
Nematoda					
Capillaria michiganensis	Aux.	Aux.	Main	-	-
Capillaria pachyderma	Main?	Aux.	Aux.	-	-
Contracaecum podicipitis	Aux.	Aux.	Main	-	-
Contracaecum sp. (immature)	?	?	?	?	?
Streptocara crassicauda	Aux.	Aux.	Main	Inhib.	-
Cosmocephalus firlottei	Aux.	Aux.	Aux.	Aux.	-
Dispharynx sp. (immature)	Inhib.	-	-	-	-
Echinuria decorata	Aux.	Main	Aux.	Inhib.	-
Tropisurus fissispinus	Aux.	Aux.	Aux.	Aux.	-
Spirofilaria fulicae-atrae	Aux.	Aux.	Main	-	-
Acanthocephala					
Polymorphus paradoxus	Aux.	Aux.	Main	Aux.	-
Hirudinea					
Theromyzon rude	Aux.	Aux.	Aux.	Aux.	Aux.

Main - Main host

Aux. - Auxiliary host

Acc. - Accidental host

Inhib. - Inhibitory host

was needed in using this group. Because of a lack of data on many helminths some of the species in this group will probably be moved to another. Any parasite which seemed to occur mainly in grebes and which was found in the highest intensity and extensity was placed in the main host category. A helminth which had been reported from another animal was placed in the main host category only if it was known to occur more typically in a grebe. For example, _Capillaria michiganensis_ was found in nine percent of the muskrats examined in Michigan (Read, 1949) but was placed in the main host category because 34 percent of adult _Podiceps grisegena_ were infected. _Petasiger nitidus_ in _Podilymbus podiceps_ was placed in the main host category with reservations because of the small sample of the host. _Lateriporus_ sp., although only one specimen was found, was placed in the main host category because it has as yet not been reported from any other host.

The auxiliary group was the most used category (78 times). A relationship between a given parasite and a given host was placed in this category if the parasite was more common in some other host. To be included in this group, the helminth of a given host-parasite relationship was common in the given host. Although _Echinochasmus donaldsoni_ and _Stephanoprora pseudoechinata_ were not found in even moderate extensity they were placed in this group because they are common in grebes in other areas (Beaver, 1941 and Linton, 1928). _Cotylurus pileatus_ was placed in the auxiliary group because of a lack of data concerning its relationship with _Aechmophorus occidentalis_

and with its other hosts (larids and alcids). It was quite common in the Western grebes examined so this may be its main host.

The accidental host group includes those relationships in which the helminth is found only rarely in a particular host and is common in others. Eight relationships were placed in this category. _Dendritobilharzia anatinarum_ was tentatively placed in this group although it may be more common. Data on its true intensity and extensity in grebes awaits special examination for it.

Eight relationships were placed in the inhibitory host category. This category includes those relationships in which the helminth fails to mature in the given host. The forms placed in this category occurred characteristically in small numbers (2 _Streptocara crassicauda_, 1 _Echinuria decorata_, and 4 _Dispharynx_ sp.) except for _Orchipedum tracheicola_ and _Lateriporus_ sp. (immature) which occurred in moderate numbers (one to 22 per host). It is assumed that worms not maturing remain only temporarily in a host hence are not found as often as worms which mature. The worms are apparently successful in entering the host but appear to be prevented from maturing by some physiological resistance of the host.

Contracaecum sp. (immature) was not placed in any group because of the possibility of being immature _Contracaecum podicipitis_. Because so few _Podilymbus podiceps_ were examined the grouping of their parasites is tentative.

On the basis of this classification one may draw some

conclusions about the phylogenetic relationships of the grebes from their relationships to the parasites. *Podilymbus podiceps* will not be considered because of the very few specimens of birds and worms obtained.

The presence or absence of helminth species could be used to compare birds of the genus *Podiceps* and *Aechmophorus*. However, this would not be accurate because of the vastly greater numbers of specimens of *Podiceps* which were collected. A comparison can be made of the helminths found in birds of both genera. If this is done it can be seen that most helminth species (15 to 17) are found in similar numbers in both genera, but two very common helminths (*Streptocara crassicauda* and *Echinuria decorata*) are found in smaller numbers and in an inhibited condition in *Aechmophorus occidentalis*. No helminth species develops normally in one species of *Podiceps* but is inhibited in another of the same genus. The differences of the two above-mentioned helminths serve to indicate the differences between the two genera of grebes.

Within the genus *Podiceps* differences between the species, as illustrated by their helminth faunae, are minor. *Podiceps caspicus* shares 25 helminths with *Podiceps auritus* and 27 with *Podiceps grisegena*. *Podiceps auritus* shares 26 with *Podiceps grisegena*. It would appear from these data that differences in the helminth fauna are more useful in determining the relationships of taxa above the species level, at least in the family Podicipedidae.

The Influence of Season on the Helminthofauna of Grebes

Seasonal variation in species and numbers of parasites has been recognized by many authors (Bezubik, 1956; Bychovskaya-Pavlovskaya, 1962; and Cornwell and Cowan, 1963). Podiceps caspicus was chosen to show this variation because it afforded the most data. A combination of data from all grebes was not used because of the many variables which would be incurred, such as differences due to differential specificity of the helminths for different grebes, differences in habitat of the different grebes, and differences of the number of grebes collected at intervals during the study period.

Figures 3, 4, 5, and 6 present data on the most common parasites of Podiceps caspicus. Extensity of invasion is given for each two week period. Adults and immatures are separated.

Four major patterns of extensity are apparent. The first group consists of those parasites that show only slight trends (Capillaria michiganensis, Spirofilaria fulicae-atrae, Dubininolepis furcifera, and Schistotaenia colymba). These are parasites which are probably long lived and/or wide spread with overlapping generations. They are probably carried north by the grebes from the wintering grounds. As seen in the section on influence of host age, one species (Spirofilaria fulicae-atrae) is not found in immature birds on the breeding grounds.

In group 2 are those parasites which are not brought in from the wintering grounds but which complete their life cycle in this area (Contracaecum podicipitis, Contracaecum sp.

FIGURE 3

SEASONAL VARIATION IN EXTENSITY OF HELMINTHS IN *PODICEPS CASPICUS*

Group 1

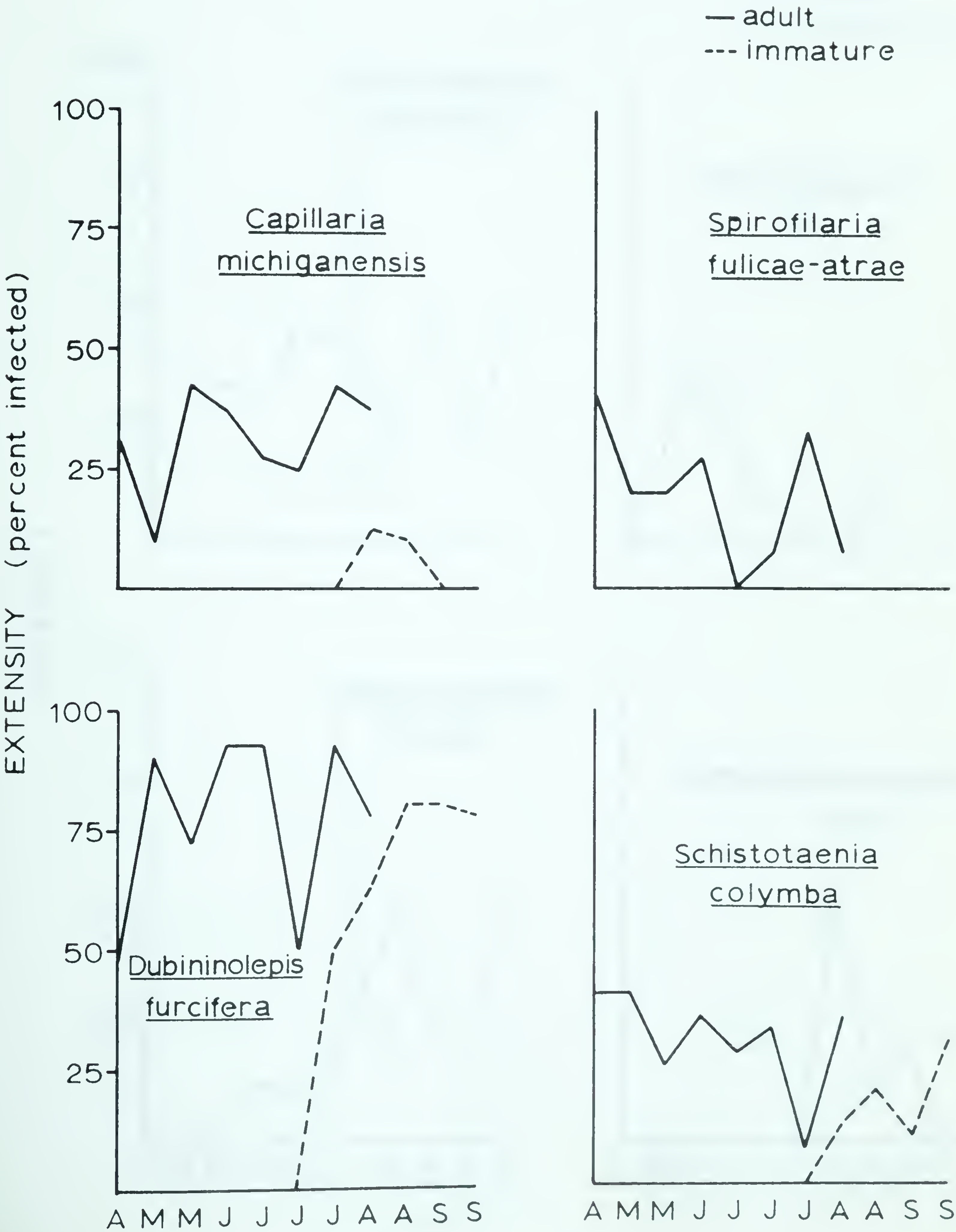


FIGURE 4
SEASONAL VARIATION IN
EXTENSITY OF HELMINTHS
IN PODICEPS CASPICUS
Group 2

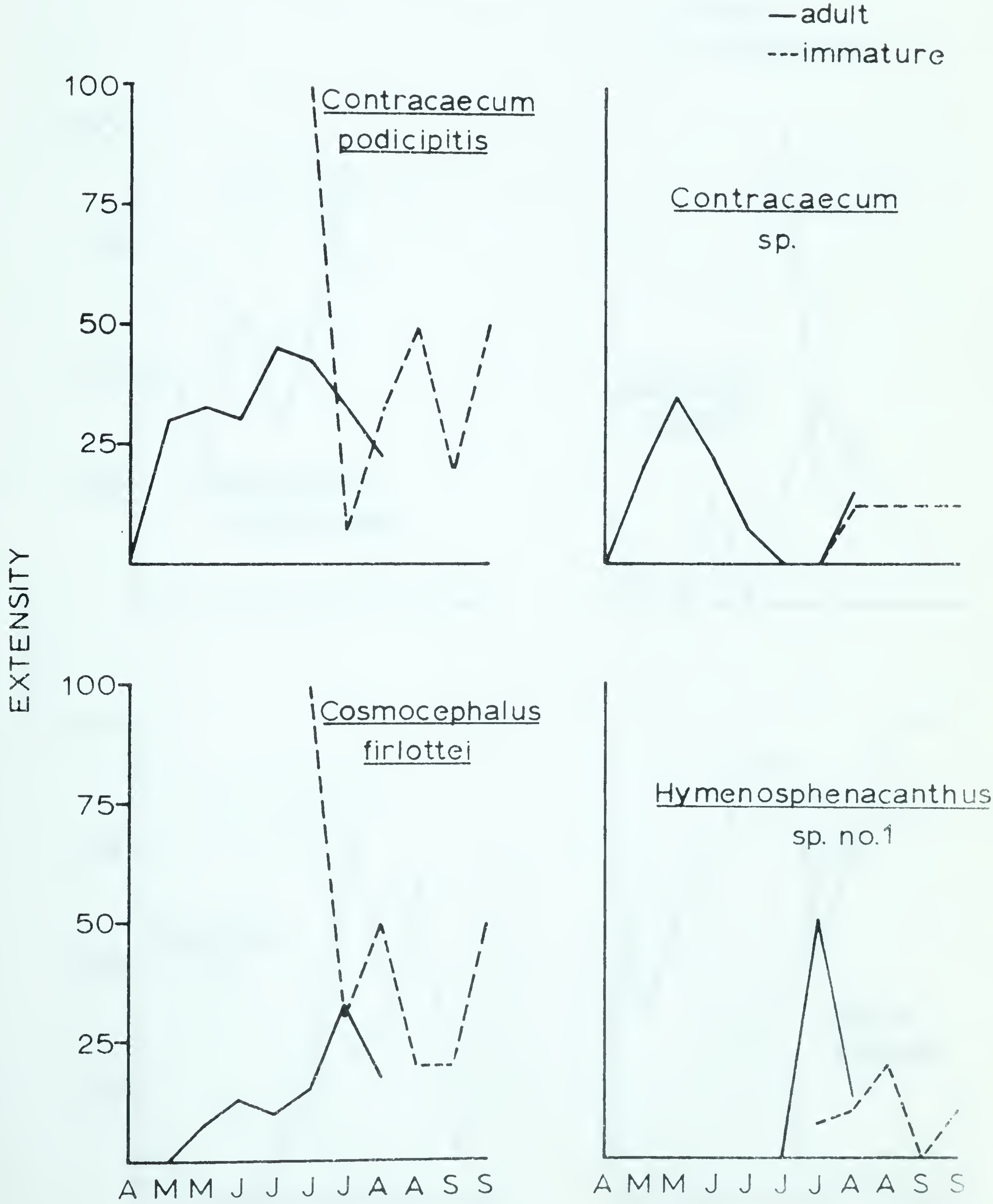


FIGURE 5
SEASONAL VARIATION IN
EXTENSITY OF HELMINTHS
IN PODICEPS CASPICUS
Group 3

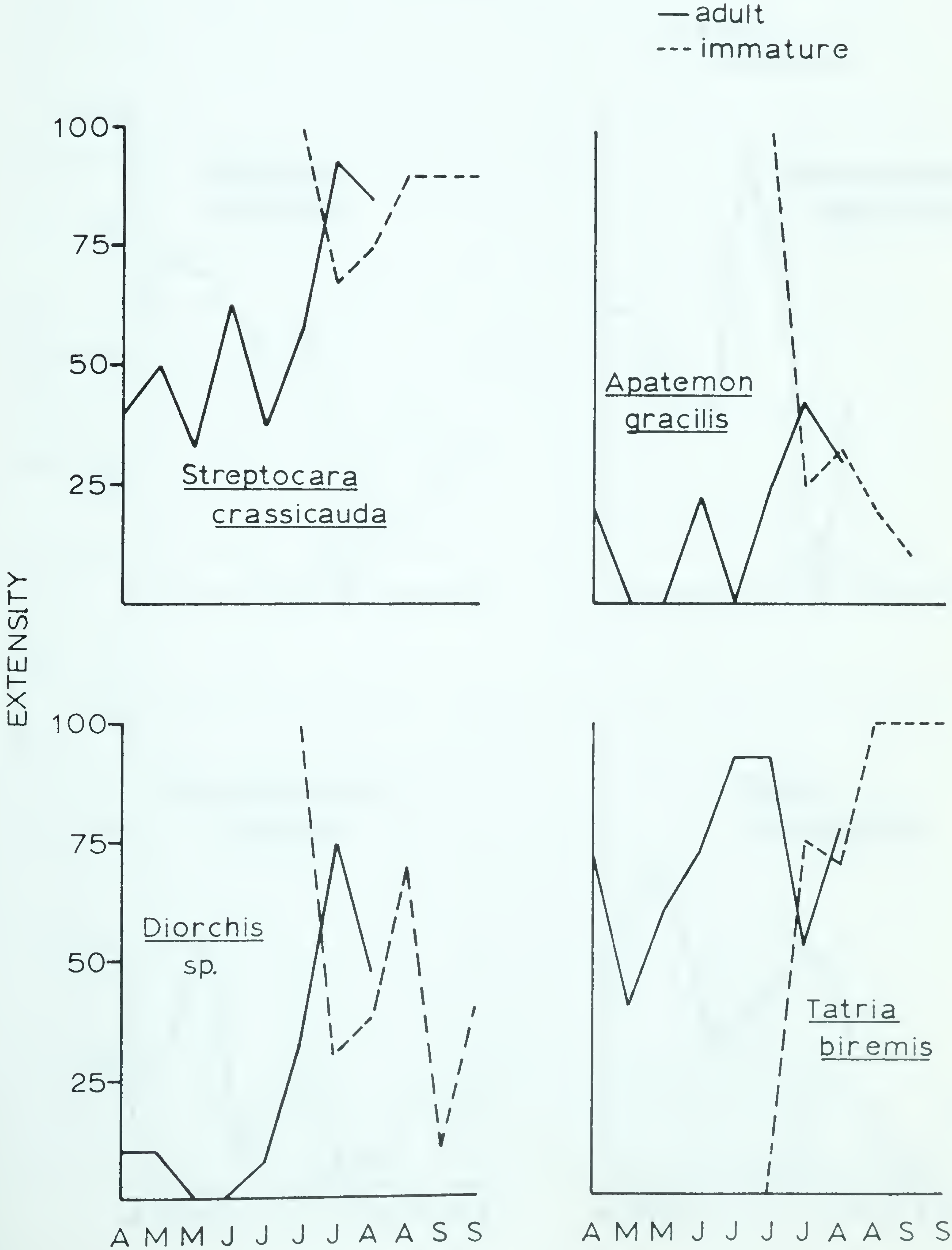
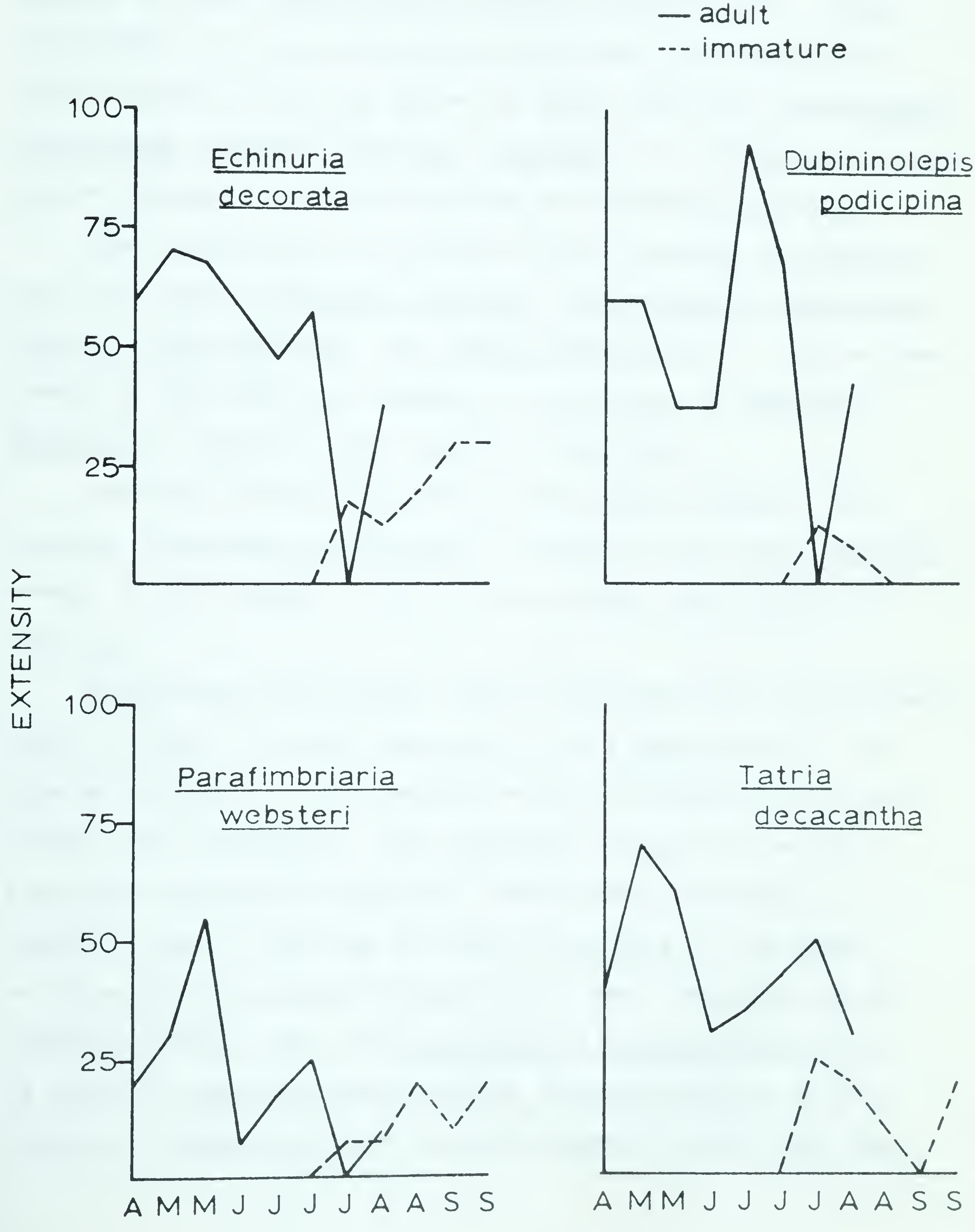


FIGURE 6
SEASONAL VARIATION IN
EXTENSITY OF HELMINTHS
IN PODICEPS CASPICUS
Group 4



Cosmocephalus firlottei, and Hymenosphenacanthus sp. #1). They are absent in the early spring.

The third group indicates those helminths found in low numbers in early spring but in greater numbers later. They are brought in in low extensity and/or are acquired quickly after arrival. The life cycles of these parasites (Streptocara crassicauda, Apatemon gracilis, Diorchis sp., and Tatria biremis) may be completed on both wintering and breeding grounds.

The fourth group of helminths which decrease in extensity with the season (Echinuria decorata, Dubininolepis podicipina) Parafimbriaria websteri, and Tatria decacantha) may be more common on the wintering grounds. An increase in Echinuria decorata in immature birds occurs in the fall.

Helminths from other grebes show similar changes. For example, Orchipedum tracheicola in grebes of the genus Podiceps occurs in the spring, is lost in the summer, and returns in the fall.

Bychovskaya-Pavlovskaya (1962) concluded that the helminthofauna of birds is mainly generated in the nesting area. My data as indicated in the section on the influence of host age support this statement. Most parasites found only in adult birds were accidentals which by chance were not found in immature birds, a few may be normal parasites of the birds on the wintering grounds brought in in small extensity to the breeding grounds, and one (Spirofilaria fulicae-atrae) which is found in moderate numbers may be transmitted only on the wintering grounds, although long development in the bird may

have precluded it from our examinations of immature birds.

Bezubik (1956) in his consideration of the seasonal dynamics of duck helminths made several generalizations for the patterns of extensity. He found that the extensity of invasion of trematodes increased slightly from spring to summer then remained constant into the fall. The only trematode we considered (Apatemon gracilis) increased erratically until mid-summer, but then decreased in the fall. A summer peak of cestodes mentioned by Bezubik (1956) was seen in Diorchis sp., Dubininolepis podicipina and Hymenosphenacanthus sp. #1, Dubininolepis furcifera however remained at a high extensity, Parafimbiraria websteri and Tatria decacantha decreased in the summer, and Tatria biremis increased gradually then dropped in the summer in adult grebes but increased to 100% in the fall in immatures. Bezubik found the nematodes to be most extensive in the spring. This was the case with Echinuria decorata, Capillaria michiganensis, Contracaecum sp., and perhaps Spirofilaria fulicae-atrae in Alberta grebes. The others (Contracaecum podicipitis, Streptocara crassicauda, and Cosmocephalus firlottei) showed an increase with the season.

Seasonal changes may also be seen in the intensity of helminth infections. Figures 7, 8, and 9 illustrate the intensity of parasite infections in Podiceps caspicus, P. auritus, and P. grisegena for each two week period. On these graphs are included data on the total parasite infections. This in reality reflects numbers of cestodes which group included the greatest number of helminths. The number of birds examined is

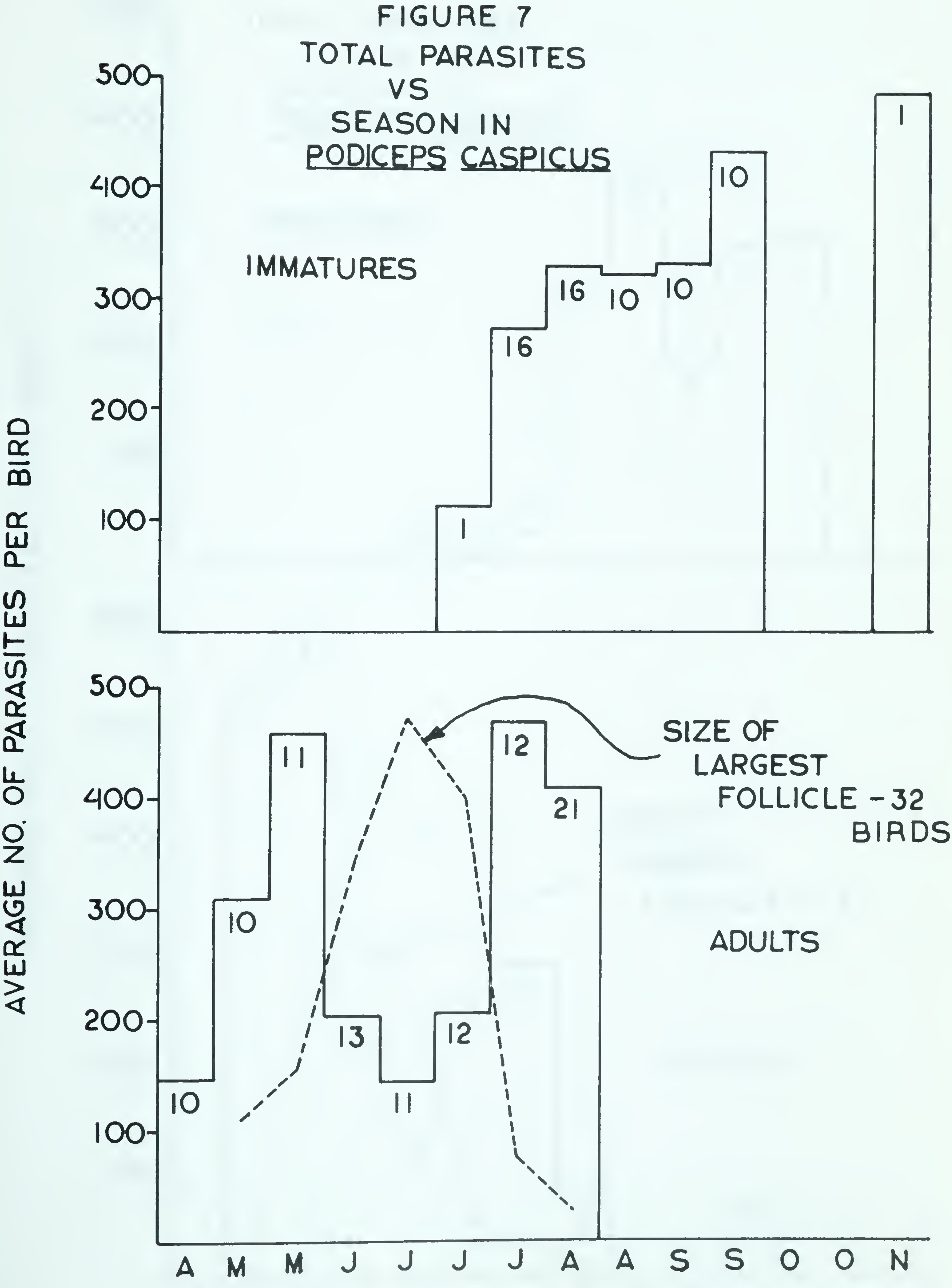


FIGURE 7
TOTAL PARASITES
VS
SEASON IN
PODICEPS CASPICUS
AVERAGE NO. OF PARASITES PER BIRD
IMMATURES
500
400
300
200
100
1
16
16
10
10
10
1
ADULTS
SIZE OF LARGEST FOLLICLE - 32 BIRDS
10
10
11
13
11
12
12
21
A
M
M
J
J
J
J
A
A
S
S
O
O
N

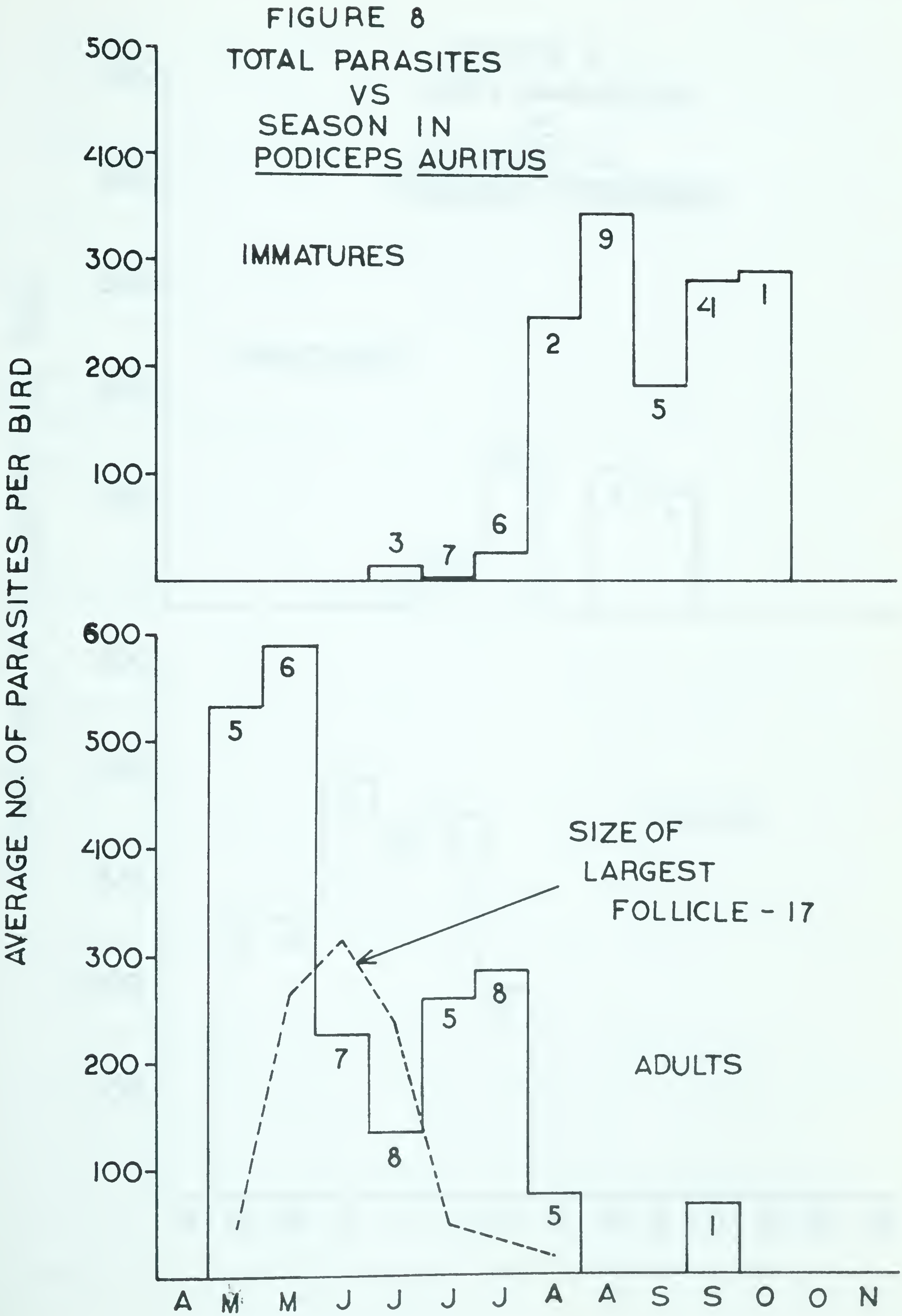


FIGURE 8
TOTAL PARASITES
VS
SEASON IN
PODICEPS AURITUS
IMMATURES
ADULTS
SIZE OF
LARGEST
FOLLICLE - 17
AVERAGE NO. OF PARASITES PER BIRD
A M M J J J J A A S S O O N

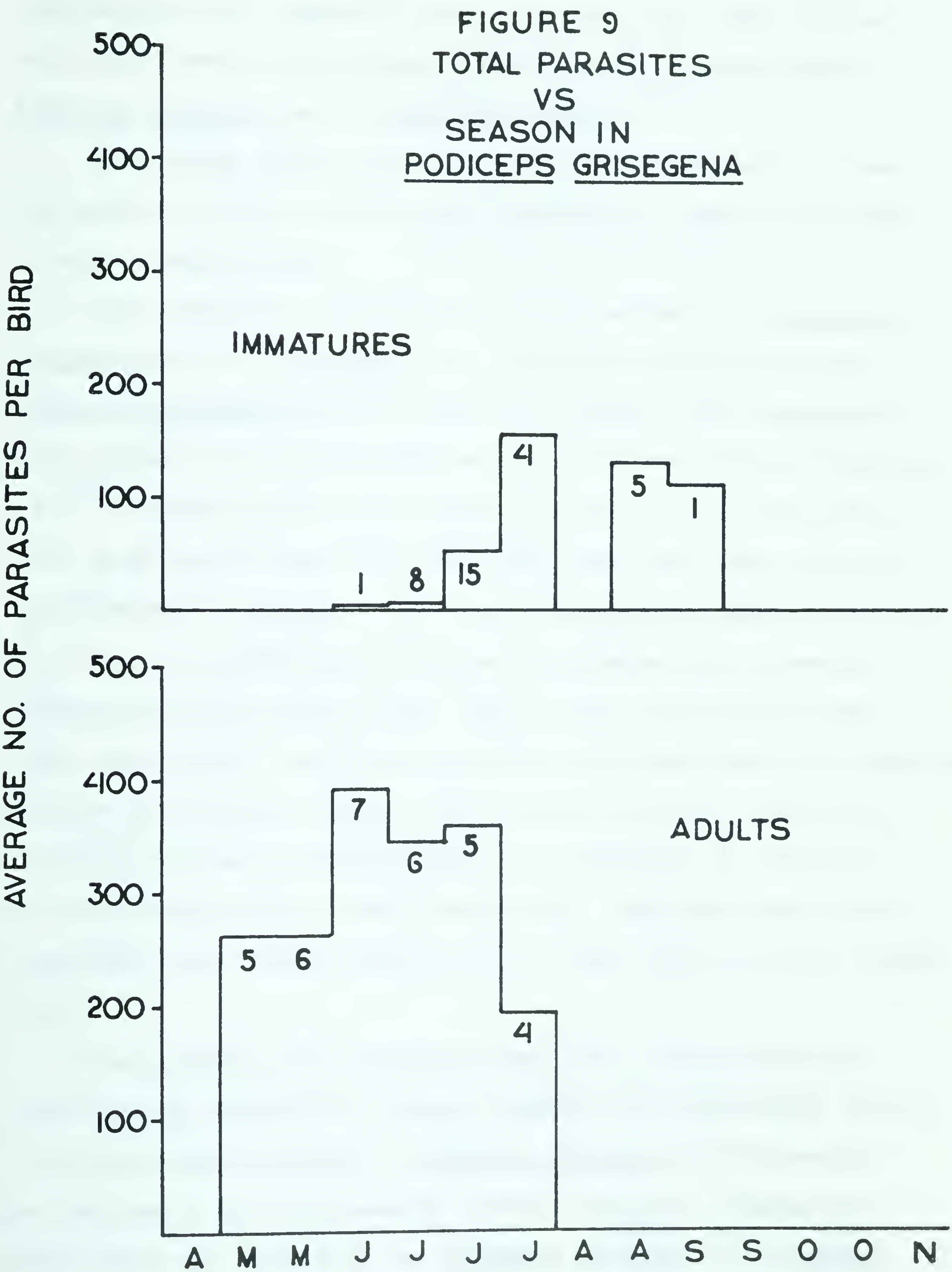


FIGURE 9
TOTAL PARASITES
VS
SEASON IN
PODICEPS GRISEGENA
AVERAGE NO. OF PARASITES PER BIRD
500
400
300
200
100
IMMATURES
1
8
15
4
5
1
ADULTS
7
6
5
5
6
4
A M M J J J J A A S S O O N

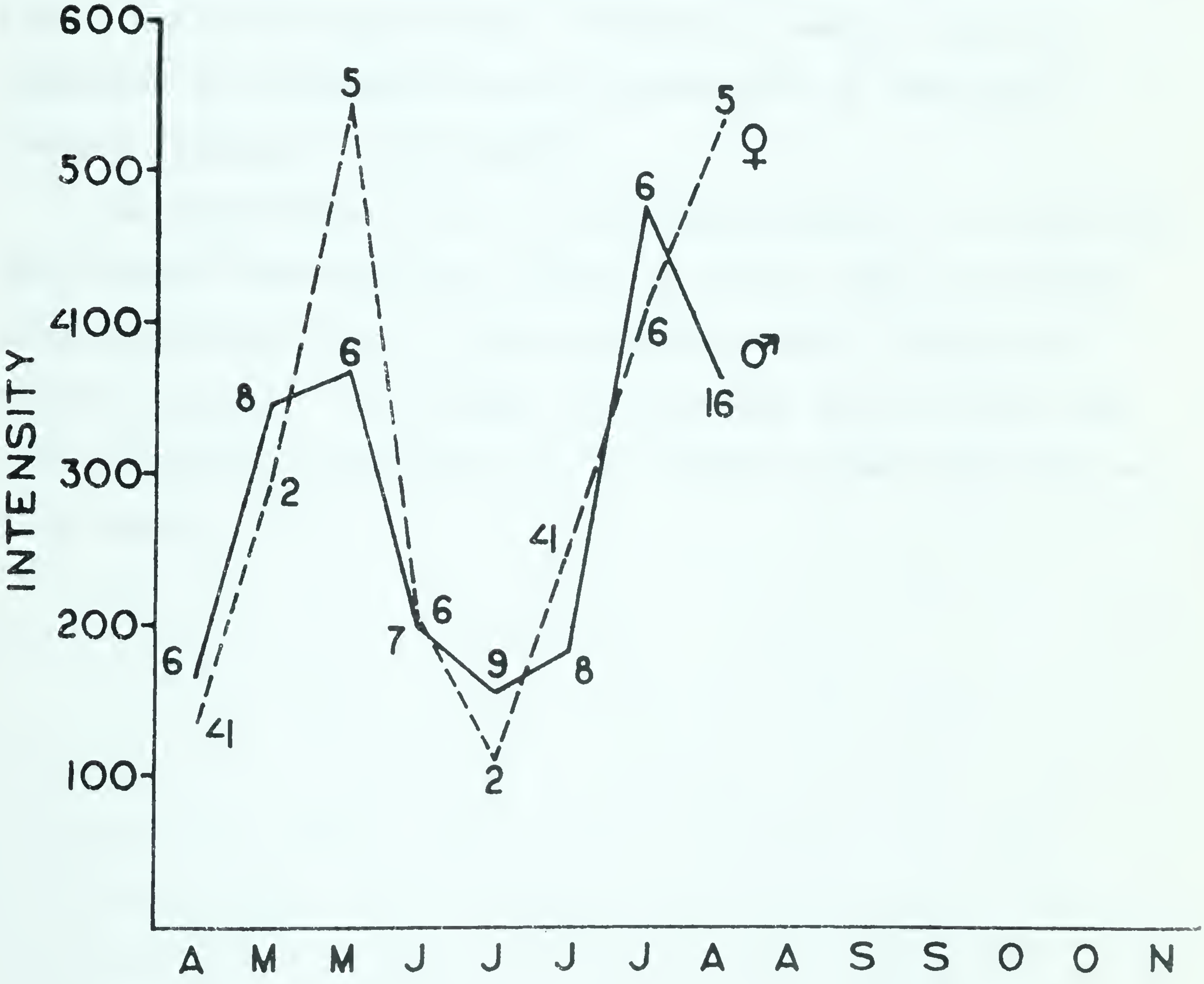
indicated by the number at the top of the bar. The ovarian follicle diameter was plotted on the basis of data from 32 Podiceps caspicus and 17 Podiceps auritus.

Each graph shows a gain in intensity of infection from the grebe's arrival in the early spring to a peak at the end of May or early June.

Then intensity of infection drops markedly in Podiceps caspicus and in P. auritus to a low about the end of June. Podiceps grisegena does not show this drop. This remarkable drop appears to be correlated with egg laying and/or incubation as is indicated by the development of the ovarian follicles. This drop occurs about the time that the first eggs are laid and ends with hatching. This loss of parasites may be related to hormonal or behavioral changes associated with breeding. Several authors (Addis, 1946; Beck, 1952; and Lees and Bass, 1960) have found that hormones affect the development of cestodes. Because both sexes incubate the hormonal levels in each are probably similar and hence there is a decrease in intensity of infection in both sexes (Figure 10). Behavior may also be important but a rough examination of food habits did not reveal this.

The increase of intensity after this period could be explained by a return to normal hormonal and behavioral levels. The higher peak reached in Podiceps caspicus could possibly be the result of the presence of more infected intermediate hosts than are available for Podiceps auritus. As Podiceps caspicus is a colonial species a greater seeding of parasites

FIGURE 10
TOTAL PARASITES
VS
SEASON IN
♂ AND ♀
PODICEPS CASPICUS



would take place in the area of the colony and because of the habitat a more varied fauna of invertebrate intermediate hosts would be present. A turn over in the intermediate host fauna as is indicated in the section on influence of habitat may further reduce the infected intermediate hosts in the ponds.

The drop in intensity before the migration of adult grebes may be the result of physiological changes (acquiring resistance to the parasites), ecological reasons (loss or reduction in intermediate host populations) or behavioral reasons (changes in food habits).

The young birds show a rather simple pattern of infection. They acquire the parasites gradually until a peak is reached, after which the level of parasitism may remain constant or decline slightly. The sample size for the late fall was too small to permit conclusions on the status of parasite load at this season.

The Influence of Host Habitat on the Helminthofauna of Grebes

The habitat (entirely aquatic) of grebes on the breeding grounds in Alberta comprises ponds, sloughs, and lakes. Ponds are bodies of water two acres or less in area with muddy bottoms and much floating and emergent vegetation. Sloughs are bodies of water more than two acres in area, shallow, with muddy bottoms, shores lined with emergent vegetation, and unstratified in summer (Big Island Lake, Cooking Lake, Hastings Lake, and Joseph Lake). An unstable fish population, mainly brook stickleback, *Eucalia inconstans*, is typical of these bodies of water. Lakes are large bodies of water that are stratified in summer (modified from Bennett, 1962). They have relatively smaller populations of invertebrates when compared to the other two habitats but have a large, diverse and stable fish population. All lakes on which grebes were collected, with the exception of Barrier Reservoir, are considered by Thomas [1959] to be eutrophic.

Migrating grebes are restricted to larger lakes in the spring and fall. On arrival in the spring some birds move to sloughs and ponds, others remain to breed on the lakes. *Podiceps auritus* characteristically breeds on small ponds; *Podiceps caspicus* generally breeds on sloughs; *Podiceps grisegena* is found on sloughs and lakes, and *Aechmophorus occidentalis* remains on the lakes. Not enough is known about *Podilymbus podiceps* in this area to make any statements about its preferences. Bent (1919) indicates that its requirements are similar to those of *Podiceps auritus*.

Sloughs and ponds are more productive than are lakes (Welch, 1952). Therefore it would be expected that greater numbers of intermediate hosts would be present in sloughs and ponds, and the birds inhabiting these small bodies of water would be more heavily infected than lake-inhabiting birds.

It is proposed that the slough habitat has the most diversified invertebrate intermediate host fauna and therefore should support the most diverse helminth fauna in birds found on it. Ponds, although eutrophic, are thought to have a limited variety of intermediate hosts present. The helminth fauna of ponds is thought to be more restricted because seeding by migrating birds does not take place as often as in larger bodies of water. Ponds can be compared to islands which by chance have not acquired certain animals. Probably lakes have a less diversified invertebrate intermediate host fauna than sloughs or ponds.

From the stand point of parasitology, an important aspect of lakes is their fish populations. These serve as intermediate hosts for a helminth fauna not found in birds on ponds, and rarely in birds on sloughs. The presence of fish serves to increase both quantitatively and qualitatively the helminth fauna of birds on lakes which otherwise would have an impoverished fauna. Hence one expects to find a helminth fauna of birds from lakes that is different from that of birds of sloughs and ponds, and a fauna from ponds that is a diminution of that of sloughs.

Table XXXVII shows that sloughs have the most heavily

Table XXXVII

Structure of the Helminthofauna of Grebe Habitats.

	Lakes	Sloughs	Ponds
No. of birds examined	38	254	52
No. of species of trematodes	10	13	7
No. of species of cestodes	11	19	8
No. of species of nematodes	6	9	8
No. of species of acanthocephala	1	1	1
No. of species of leeches	1	1	1
Total no. of parasites	29	43	25
No. of distinctive species	3	13	1
Intensity (Av. no. of parasites per bird).	217	349	205

infected grebes, lakes support the second heaviest infections (probably due to the presence of infected fish) and ponds the lightest infestations;sloughs support the most diverse helminth fauna, lakes are intermediate (due to the presence of fish), and the fauna of ponds is the least diverse. Although the large number of birds collected from sloughs is thought to affect the number of helminth species found, it is not important enough to change the deductions because after the examination of a certain number of birds (25 - 30) most of the species of helminths occurring in grebes have been found.

A comparison of the helminths of all grebe species from different habitats is not accurate because of the effects of host specificity of the helminths for different grebes. It is best to compare the helminths of populations of a single species from different habitats. This has been done (Table XXXVIII) for <u>Podiceps</u> <u>auritus</u>. Immature <u>Podiceps</u> <u>auritus</u> collected from home ponds and birds taken in the fall on lakes are considered. Table XXXVIII shows that the helminth fauna of the birds in the two habitats is quite different. Although only two birds were collected from lakes, five of the eight species of helminths found in them were different from those of the 20 birds taken from ponds. These five parasites all have fish as intermediate hosts.

Grebe parasites are mainly biohelminths. Food, therefore, is the most important infective factor in the habitat of grebes. Hence if an intermediate host is present in a particular habitat so also will be the parasites associated with it (providing the

Table XXXVIII

Occurrence of Helminths in Immature *Podiceps auritus* examined from Ponds and Lakes.

	Immature Birds on Home pond (no fish).	Birds on Lakes (fish)
	20 birds	2 birds
Eucotyle cohni	*	X
Notocotylus attenuatus	X	
Dubininolepis furcifera	X	X
Parafimbriaria websteri	X	
Schistotaenia sp.	X	
Schistotaenia colymba	X	
Tatria biremis	X	
Tatria decacantha	X	
Contracaecum podicipitis	X	
Streptocara crassicauda	X	
Cosmocephalus firlottei	X	
Theromyzon rude	X	
Cotylurus erraticus		X
Cotylurus platycephalus		X
Ribeiroia thomasi		X
Petasiger nitidus		X
Ligula intestinalis		X

* probably found in ponds, but not seen because of low extensity.

hosts are there to infect it).

In summary, because of their eutrophic character, diversified intermediate host fauna, and large population of transient and nesting birds the sloughs are the richest area for helminth infection. Ponds, although also eutrophic, have fewer intermediate hosts, and are less exposed to seeding with parasites. Lakes are less productive, and support a less diverse invertebrate intermediate host fauna than the other two and would support a smaller parasite population, except for the presence of fish.

The Influence of Age of Host on its Helminth Fauna

It is difficult to accurately determine the age of immature grebes. The only suitable method was worked out by McAllister (1963) for the Pied-billed grebe (Podilymbus podiceps). She used weight, plumage, and other anatomical structures (egg-tooth, color of the iris and scales of the legs, and changes in the bare skin spots on the head) to establish a calendar of growth. Because the grebes which I have studied are quite different from Podilymbus podiceps and because no time was available to work out a suitable ageing technique, only a correlation with weight will be used. This technique is crude (because of the large variation) and fails when the birds reach adult size; but it is the only one available.

Very few parasites found in grebes do not complete their life cycle on the breeding grounds. These can be illustrated by noting which of the helminths of adult grebes are not found in the young (Table XXXIX).

Among the parasites which were reported only from adult birds are accidental parasites found on a very few occasions. These helminths may also infect young grebes but probably because of the low incidence of infection they were, by chance, not found. These are: Nadejdolepis sp., Hymenosphenacanthus sp., Dendritobilharzia anatinarum, and Dispharynx sp. Another group of parasites found only in adult birds are those which are acquired on the wintering grounds (ocean). These may be: Tetrabothrius immerinus, Stephanoprora pseudoechinata, and Maritrema japonicum. Dicranotaenia sp. was found in Aechmophorus

Table XXXIX

Helminths Restricted to Adult or Immature Grebes.

Found only in adult grebes	Found only in immature grebes
Dicranotaenia sp.	*Notocotylus attenuatus*
Tetrabothrius immerinus	*Plagiorchis maculosus*
Nadejdolepis sp.	*Schistotaenia tenuicirrus*
Hymenosphenacanthus sp. #2	
Stephanoprora pseudoechinata	
Dendritobilharzia anatinarum	
Maritrema japonicum	
Spirofilaria fulicae-atrae	
Capillaria pachyderma	
Dispharynx sp.	

occidentalis of which only a few specimens were taken, and so this parasite may be found in immatures when more birds are collected. The remaining nematodes (*Spirofilaria fulicae-atrae* and *Capillaria pachyderma*) may not have been found because either they do not complete their life cycles in this area, or because development in the grebe may take longer than the time spent by the birds in this area. This is almost certainly the case for *Spirofilaria fulicae-atrae* as related forms have shown a rather lengthy development in the definitive host.

The parasites found in the young should be found in the adults with the exception of "juvenile" parasites (parasites of organs such as the bursa of Fabricius). The three helminths found only in young grebes can be easily explained. The species *Notocotylus attenuatus* and *Plagiorchis maculosus* are accidental parasites found on two occasions and probably by chance not found in adult grebes. The third species, *Schistotaenia tenuicirrus* was found in an immature *Podilymbus podiceps*. No adults of this grebe were collected, hence no records for an adult grebe could be given. The only juvenile helminth found in grebes was *Cotylurus platycephalus*. This strigeid inhabits the bursa of Fabricius. Normally it would be found only in immature birds. A grebe, however, sometimes retains its bursa for a year, hence, this parasite was also found in adults.

The rate at which species of helminths are acquired by the young grebes (Figure 11 and 12) varies markedly between

FIGURE 11
ACQUISITION OF HELMINTHS
WITH WEIGHT (AGE)
IN <u>PODICEPS CASPICUS</u>
AND <u>PODICEPS AURITUS</u>

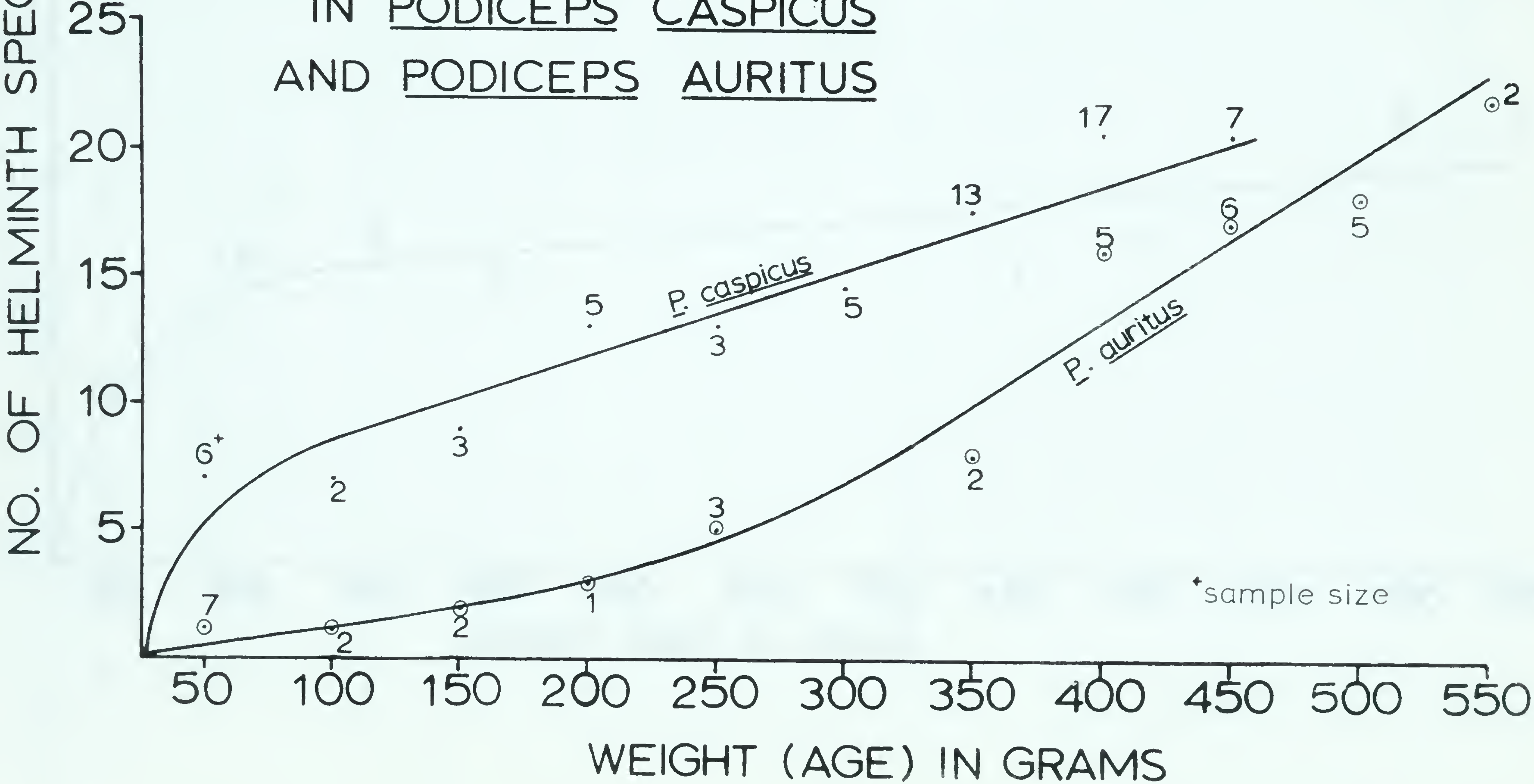
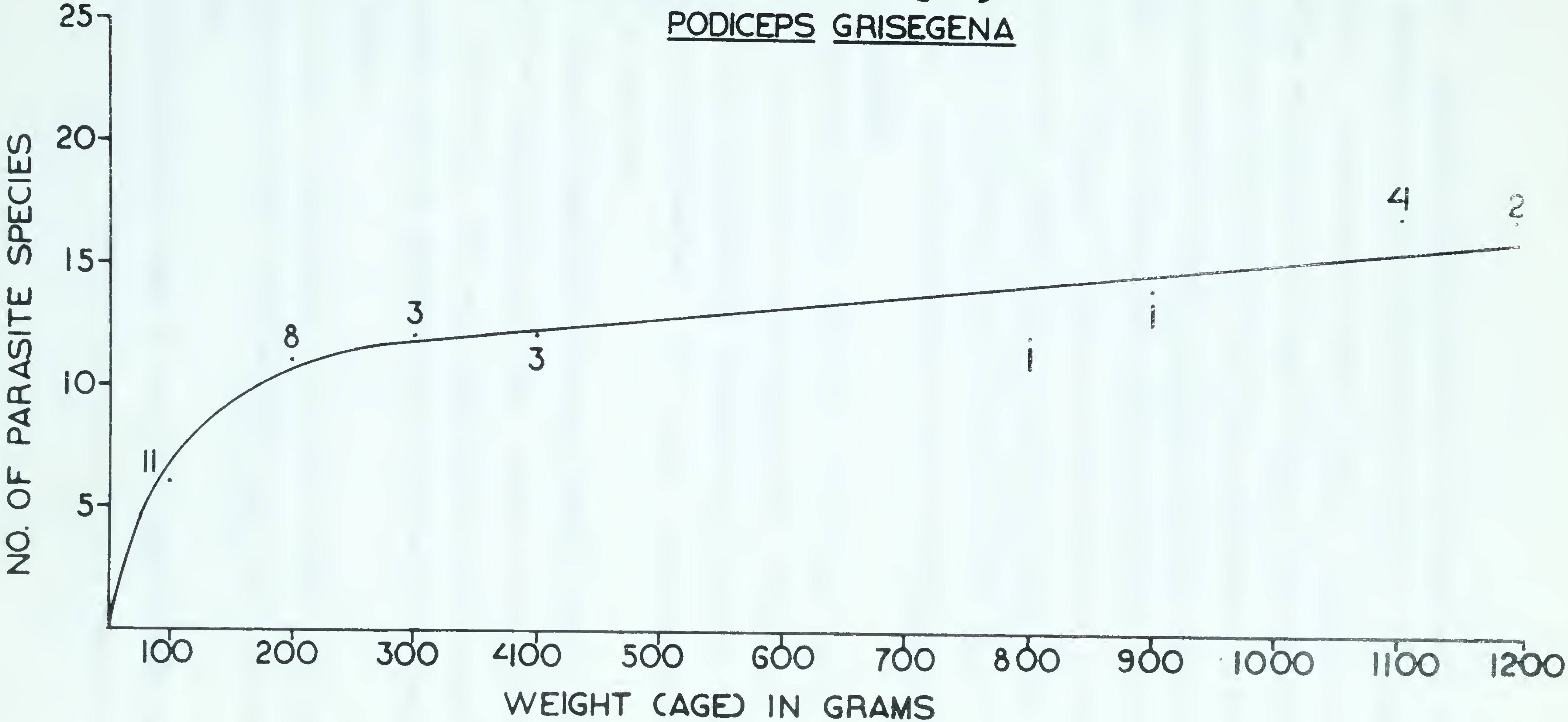


FIGURE 12
ACQUISITION OF PARASITES
WITH WEIGHT (AGE)
PODICEPS GRISEGENA



species. Podiceps auritus acquires helminths very slowly which probably reflects the habitat in which the grebes are found. A contributing factor may be a change in the population structure of at least some of the crustacean species, with adults dying and being replaced by young prior to the hatching of the young grebes (personal communication - D. Aiken). This reduces the number of infected intermediate hosts. The presence of only two adult birds in a given area would reduce the probability of infecting these young crustaceans, in contrast with an area in which there were many grebes, as in the breeding areas of Podiceps caspicus and P. grisegena.

A comparison of the extensity of invasion and the first occurrence of helminths in immature grebes (Figure 13) indicates that the commonest parasites are usually the first to be found in the grebes. The reasons for this could be several as follows:

a) chance - parasites in large numbers infect many intermediate hosts which have more chances of being eaten;

b) normality - the more common parasites are most typical of the grebes and are probably more successful in developing in the grebe;

c) ecology - efficiency of the life cycle. The most common parasites infect intermediate hosts which are eaten most often.

An examination of some of the more common grebe parasites (Figure 14 and 15) in their most typical host seems to indicate

FIGURE 13
EXTENSITY VS FIRST OCCURRENCE
OF HELMINTHS IN THREE
SPECIES OF GREBES

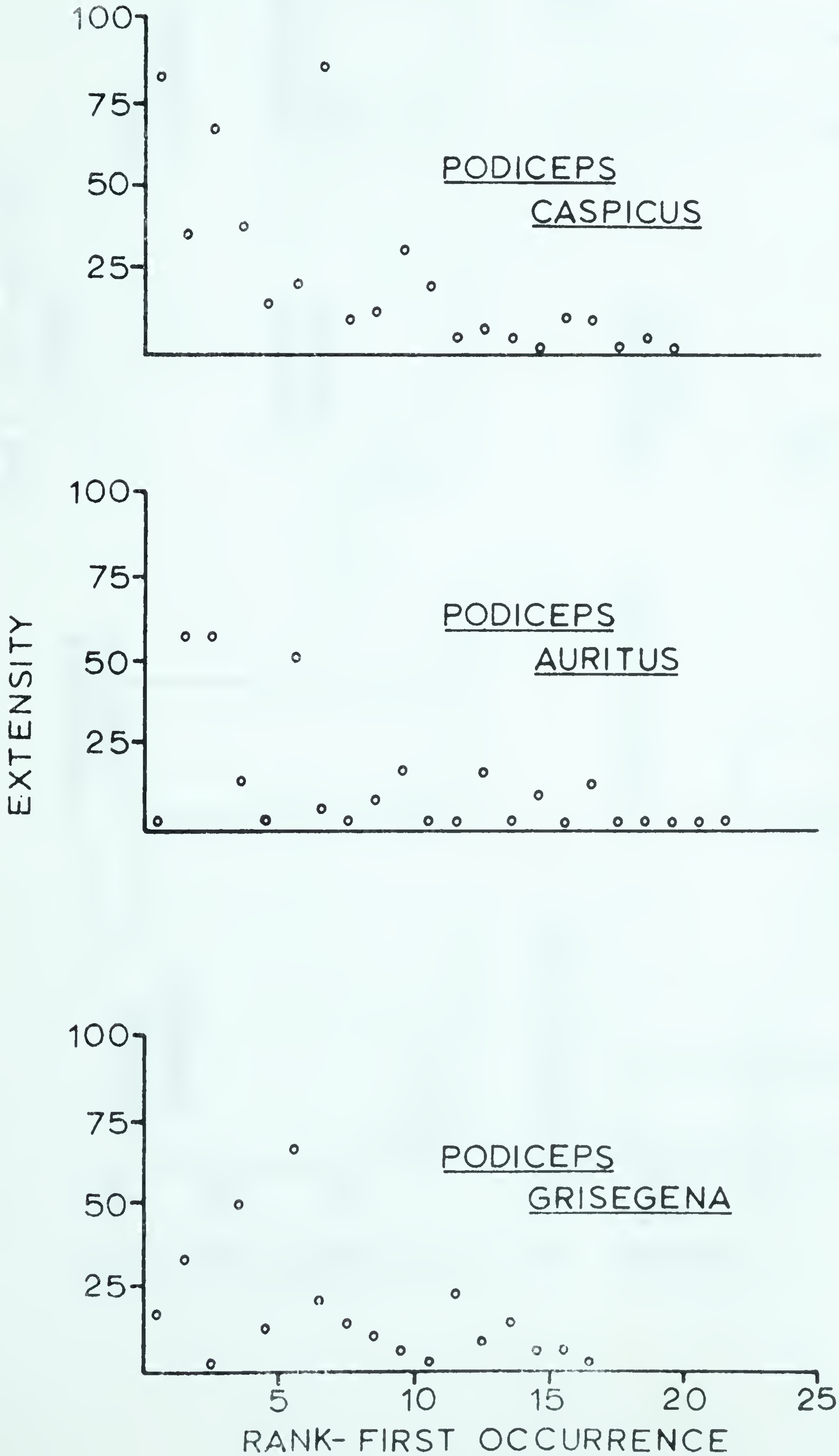


FIGURE 14
RELATIVE INFECTIONS OF
ADULT AND IMMATURE
GREBES

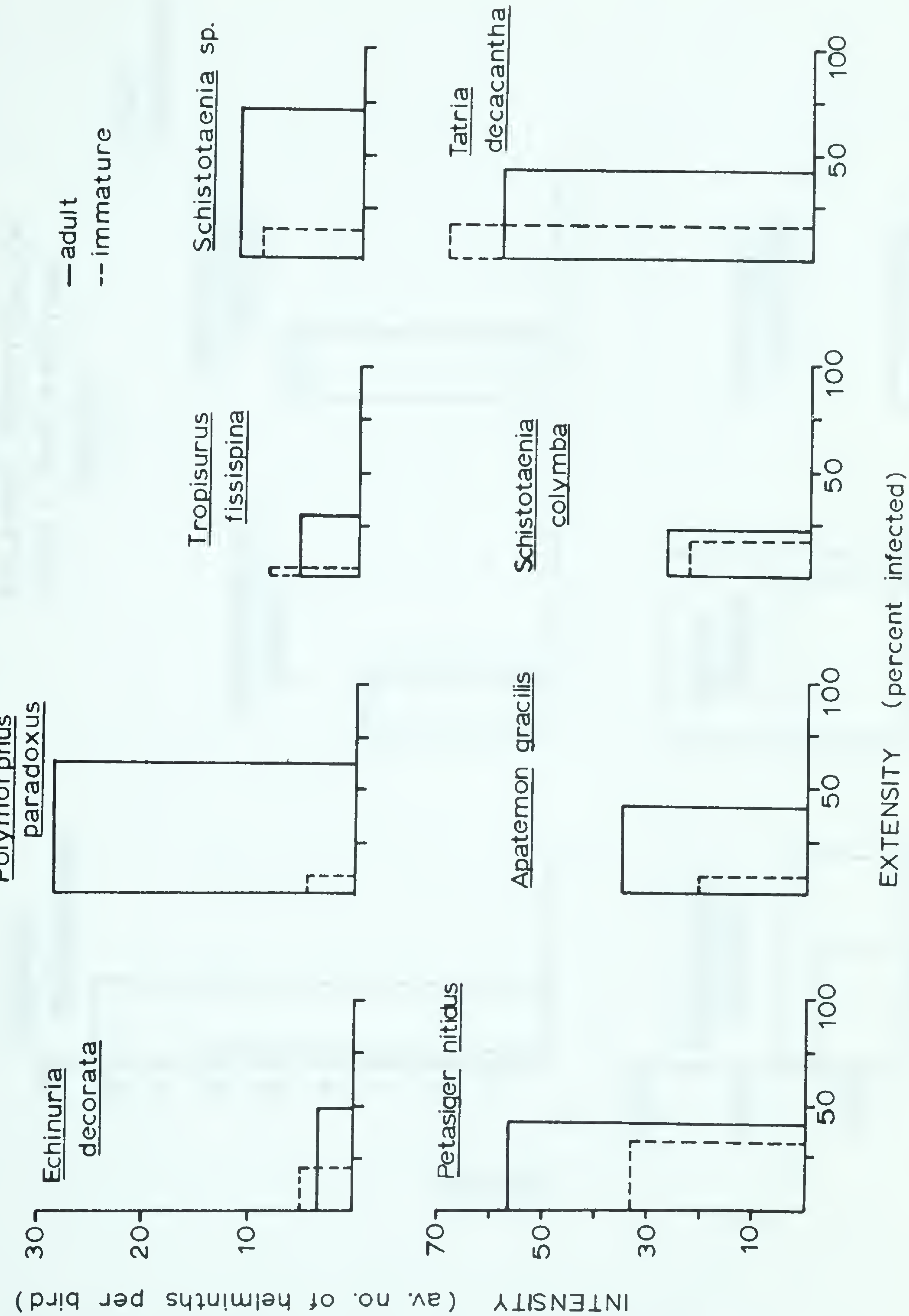
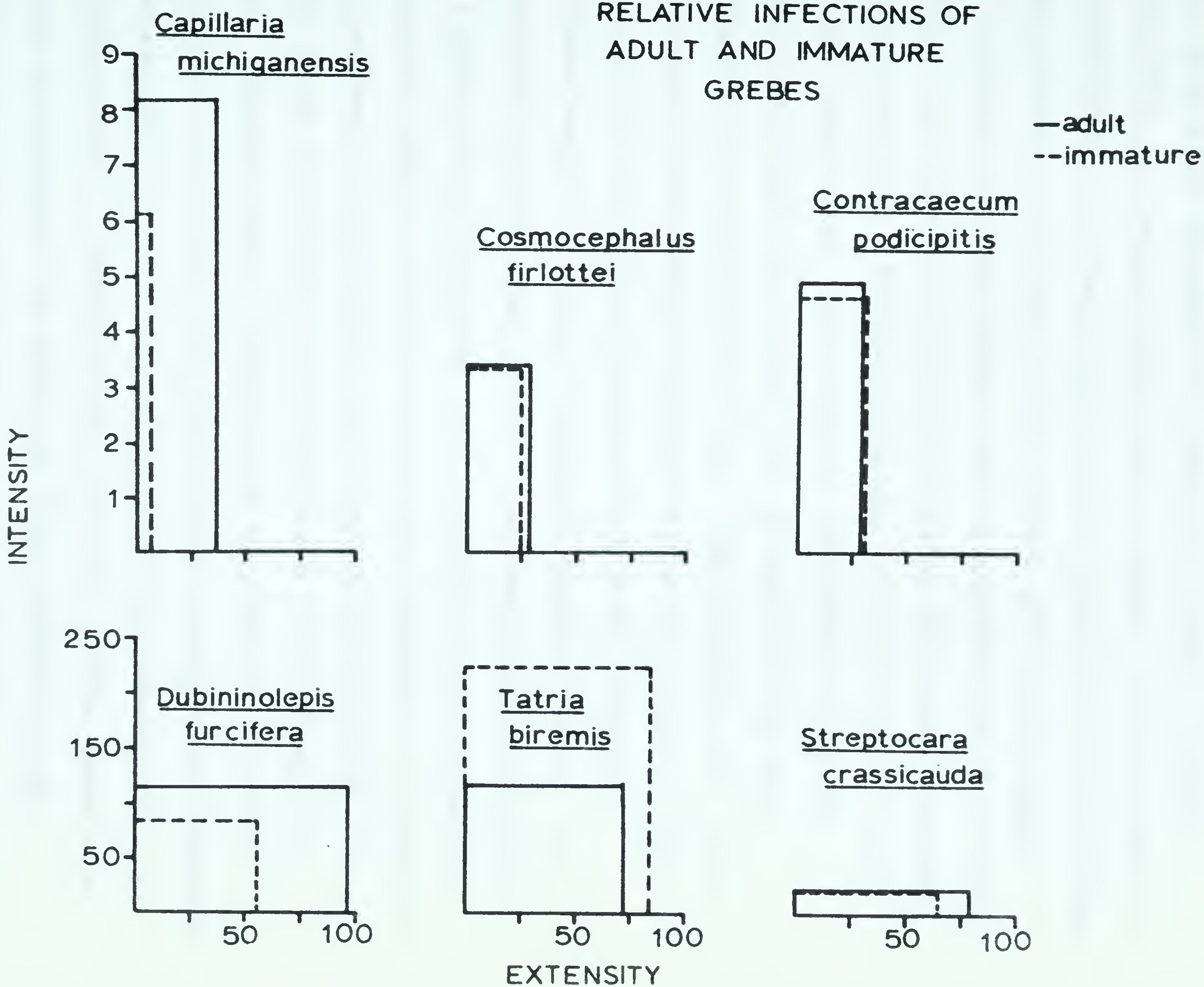


FIGURE 15
RELATIVE INFECTIONS OF
ADULT AND IMMATURE
GREBES



that only a few helminths of grebes are found in heavier infections in immature birds than in adults. This is contrary to the findings of many other authors (Bychovskaya-Pavlovskaya, 1962; Cornwell and Cowan, 1963; Lapage, 1956; inter alia).

Bychovskaya-Pavlovskaya (1962) concludes that the basic reasons for change of the helminthofauna with age is change of the host food. Although immature and adult grebes differ in food habits (see the section on the effects of food), these differences can not be tied up directly with age differences in the helminth fauna. She concludes that adult birds have a more diverse trematode fauna than young. This may be true with grebes although fully grown immatures may have nearly as diverse a helminth fauna as adults. She concludes that the commencement of an independent existence by a young bird is followed by an increase in the number of trematode species infecting it, but the extensity of infection is decreased. Young grebes are independent from early in life, hence this factor is not important in the biology of their helminth fauna. Finally, she concludes that at the time young birds leave for their winter quarters the trematode species composition of the young birds nearly equals that of the adult birds. Unfortunately, the adult grebes leave long before (mid-August) the immatures (late October) so no direct comparison can be made. However it can be seen from Figures 7, 8, and 9 that immature birds in the fall have an intensity of infection rivalling that of adult grebes in the summer.

In conclusion, food is probably the most important factor governing helminth infections in adult and immature grebes because most of the helminths are biohelminths; the most common helminths are usually the first to infect the grebes; immature grebes harbor the same helminths as the adults; and the immature birds are not usually more heavily infected than the adults.

The Influence of Feeding Habits of the Host on the Helminthofauna

During this study gizzard contents were collected from many of the grebes autopsied. The sample included contents from 154 *Podiceps caspicus*, 75 *P. auritus*, 62 *P. grisegena*, 21 *Aechmophorus occidentalis*, and six *Podilymbus podiceps*. These data plus observations by the author and studies by Wetmore (1924) and Lawrence (1950) gave some idea of the food habits of grebes.

Examination of the preserved food mass involved diluting it with water in a flat bottomed dish. The different types of food (i.e. different insect species, etc.) found floating on the surface were identified and relative numbers noted. The supernatant was then poured off leaving a residue. The residue contained most of the food and feathers. This was then diluted so that identifications and relative numbers could again be obtained. The original estimates were then revised. It was found that quantitative estimates did not add anything to the qualitative estimates which will be used.

Certain foods may remain in the gizzard for longer periods than others. This was especially noted with the mandibles of dytiscid larvae, chironomids and hard parts of insects. The many feathers in the gizzard were probably for the retention of these potentially dangerous objects (Storer, 1961).

Podiceps caspicus feeds mainly on arthropods, and takes also few fish, leeches, and molluscs (Table XL). The closely

Table XL

Percent of Occurrence of Food Items in Gizzards of Five Species of Grebes.

Identification of Gizzard Material	*Podiceps caspicus*	*Podiceps auritus*	*Podiceps grisegena*	*Aechmophorus occidentalis*	*Podilymbus podiceps*
Mollusca					
Gastropoda					
Physa sp.	1	-	-	-	-
Helisoma anceps	-	4	-	-	-
Gyraulus parvus	1	3	-	-	-
Promenetus exacuous	-	3	-	-	-
Lamellibranchiata					
Psidium sp.	1	4	-	-	-
Annelida					
Hirudinea (leeches)	6	13	18	-	33
Arthropoda					
Crustacea					
Amphipoda					
Gammarus sp.	54	23	23	5	-
(Acanthocephalan larvae)	52	32	18	5	-
Insecta					
Odonata					
Anisoptera (larval dragonflies)	1	13	3	10	-
Zygoptera (larval damselflies)	-	9	-	-	-
(adult damselflies)	1	7	5	-	-
Orthoptera					
Cyrtacanthacridinae	-	-	2	-	-
Homoptera					
Corixidae (water boatmen)	74	63	10	-	17
Notonectidae (back swimmers)	5	12	2	-	-
Cicadellidae (leaf hoppers)	1	-	-	-	-
Coleoptera					
Dytiscidae (predacious diving beetles)					
larvae	43	53	66	5	67

cont'd

Table XL (cont'd)

Identification of Gizzard Material	*Podiceps caspicus*	*Podiceps auritus*	*Podiceps grisegena*	*Aechmophorus occidentalis*	*Podilymbus podiceps*
adults	11	35	42	-	33
Coccinellidae (lady bugs)	-	1	-	-	-
Haliplidae (crawling water beetles)	18	7	-	-	17
Cerambycidae (long-horned wood-borers)	1	1	-	-	-
Elateridae (click beetles)	-	-	2	-	-
Gyrinidae (whirligig beetles)	-	-	-	-	17
Unidentified Coleoptera	7	1	11	-	-
Trichoptera (caddisfly-larvae)	7	27	16	-	-
Diptera					
Chironomidae (midges)					
larvae	33	12	-	-	-
pupae	10	9	-	-	-
adults	9	4	2	-	-
Tabanidae (horse flies)	1	-	-	-	-
Drosophilidae (fruit flies)	1	-	-	-	-
Calliphoridae (blow flies)	1	-	-	-	-
Tipulidae (crane fly-larvae)	1	-	-	-	-
Unidentified Diptera	1	-	-	-	-
Hymenoptera					
Formicidae (ants)	3	3	8	-	-
Unidentified Hymenoptera	1	-	2	-	-
Chordata					
Pisces					
Gasterosteidae					
Eucalia inconstans (Brook stickleback)	2	3	18	-	-
Percidae					
Perca flavescens (Yellow Perch)	-	-	2	29	-
Cyprinidae					
Notropishudsonius (Spottailed Shiner)	-	-	-	5	-
Fish unidentified	-	-	-	19	-
Feathers	98	92	95	100	100
Sand	5	9	13	38	-
Pieces of Stomach lining	5	1	2	-	-
Plant	9	3	8	5	17

related Podiceps auritus has similar feeding habits (Table XL). The Pied-billed grebe, Podilymbus podiceps, has similar food habits to Podiceps auritus but a small sample size makes a more detailed comparison unprofitable. Podiceps grisegena, like the other two grebes, feeds largely on arthropods. The main difference between this species and the others is that larger food (for example, adult dytiscids) is selected. There is a coincident reduction in the number of the Corixidae, Chironomidae, Haliplidae and damselfly larvae. Aechmophorus occidentalis has a completely different feeding pattern. It feeds nearly exclusively on fish, taking invertebrates only when unable to get fish. Because of the small sample of these birds taken it cannot be stated which species of fish is preferred. On Lake Wabamun the yellow perch (Perca flavescens) seems to be eaten most often with specimens up to 7 inches long being taken.

The helminth fauna of grebes varies with the specificity of the helminths which is in part correlated with food habits of the grebes. The differences in food habits related to the apparent differences in the specificity of the helminths is difficult to analyze because of lack of knowledge of intermediate hosts in this area. The obvious differences are those between grebes feeding on fish and those feeding on invertebrates. Here the differences in helminthofauna can be ascribed directly to food habits. Determination of the channels of infections of grebes feeding mainly on invertebrates must await the identification of intermediate hosts and elucidation of life cycles.

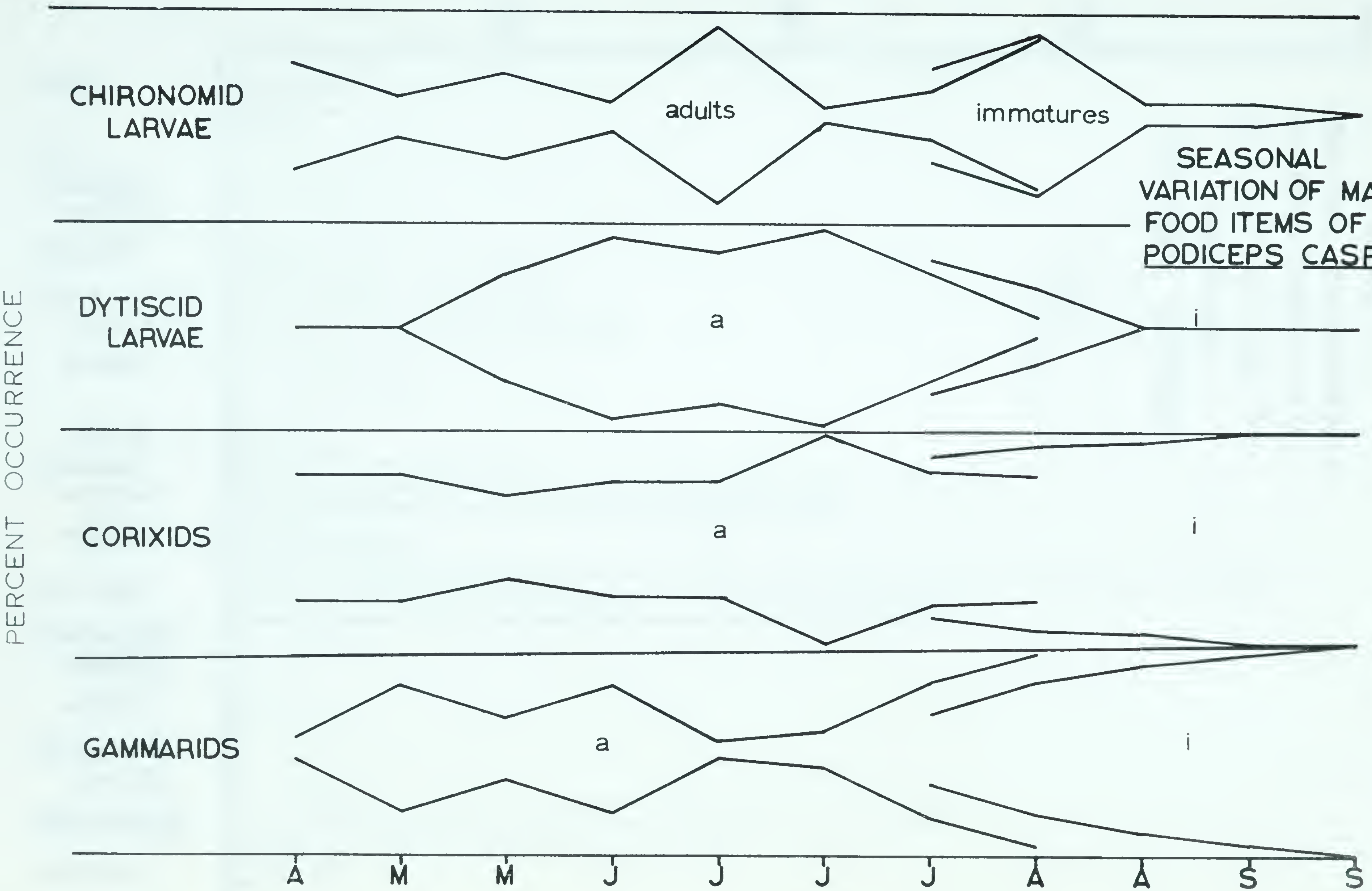
Differences in food habits due to different invertebrate faunae of different habitats probably result in differences in the helminth fauna of grebes. The only differences that can be demonstrated however, are between bodies of water with fish and those without. On the lakes birds have fish-borne parasites, while on fishless bodies of water they lack these parasites. Undoubtedly this also occurs with parasites having specific invertebrate intermediate hosts.

Seasonal differences in food habits occur in grebes (Figure 16). Seasonal differences also occur in the parasite fauna of grebes (see section on season). But relating the change in food habits to change in helminthofauna is impossible at this time because of the lack of knowledge of intermediate hosts. It is probable, however, that seasonal changes in food influences the seasonal occurrence of helminths in the grebes.

Differences of food habits between immature and adult grebes is apparent but not marked (Figure 17, 18 and 19). The immature birds seem to prefer smaller foods. The helminth fauna is also slightly different but not markedly so. The migration of adult grebes by mid-August makes a comparison of food habits and parasites between the two age classes impossible. The differences indicated on the above mentioned graphs are influenced by seasonal changes as well as behavioral, being a comparison of summer adults and fall immatures.

The majority of grebe parasites are biohelminths, that is, parasites that develop in an intermediate host. Hence

FIGURE 16



SEASONAL VARIATION OF MAIN FOOD ITEMS OF PODICEPS CASPICUS

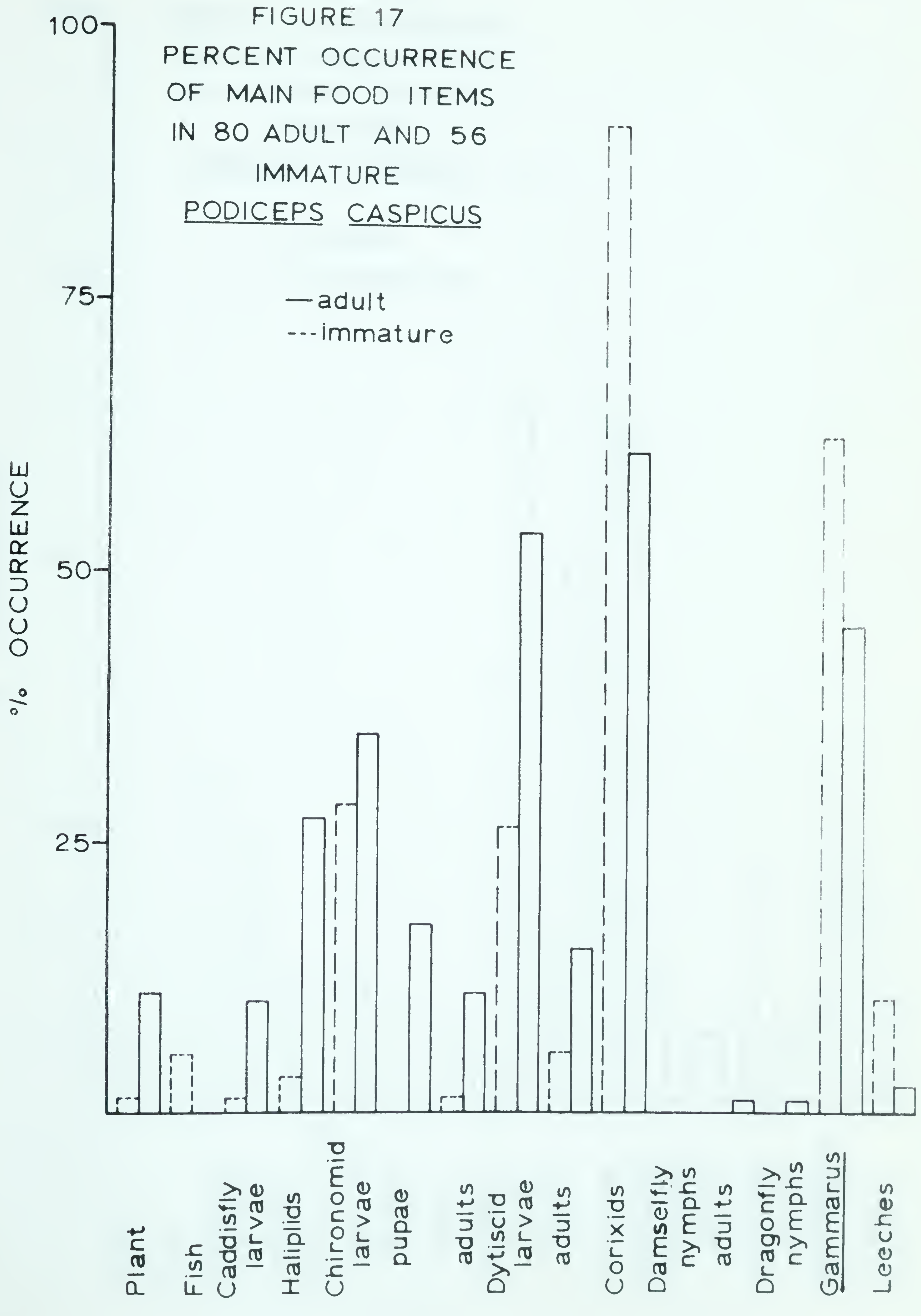
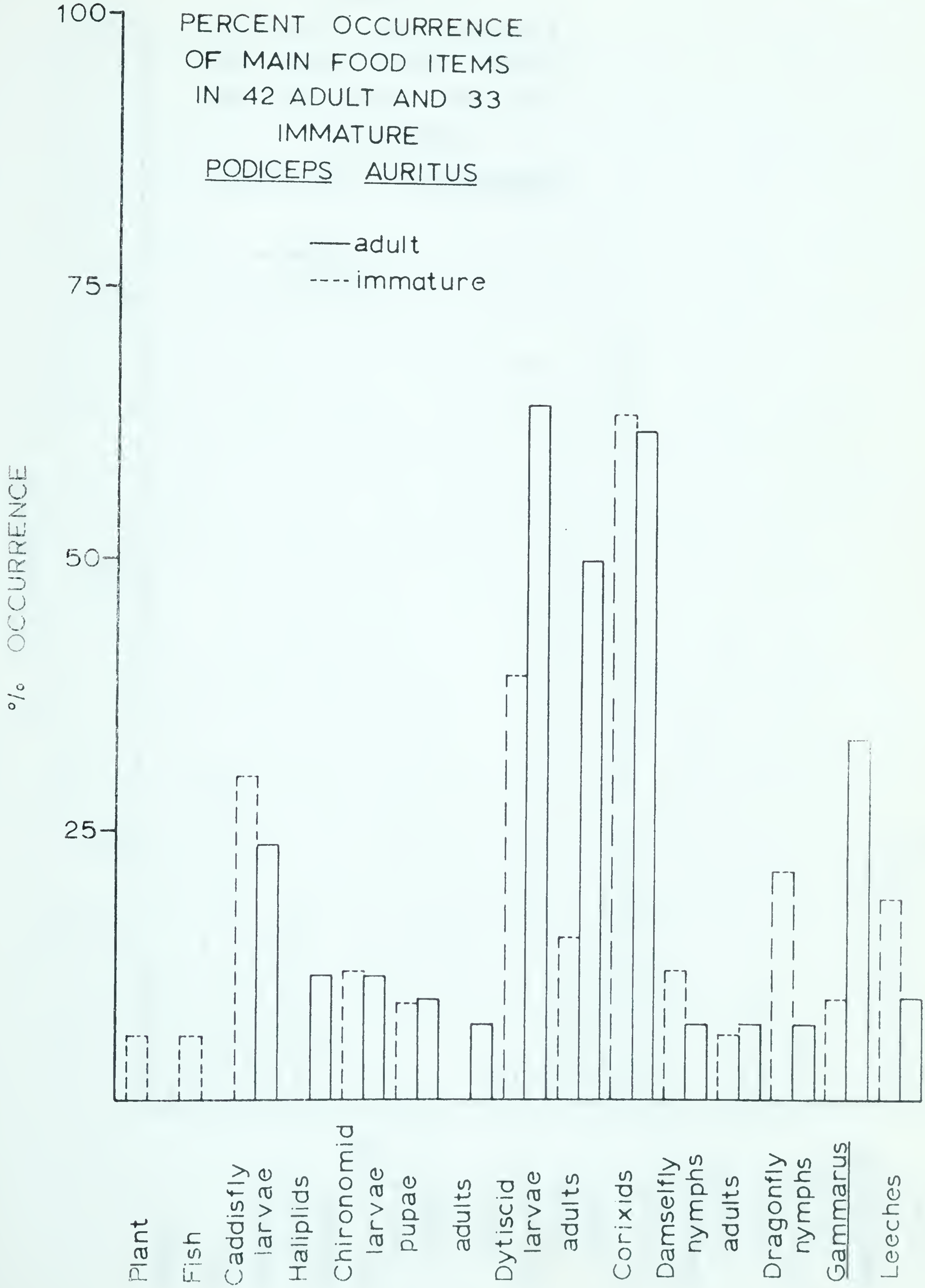


FIGURE 17
PERCENT OCCURRENCE
OF MAIN FOOD ITEMS
IN 80 ADULT AND 56
IMMATURE
PODICEPS CASPICUS
— adult
--- immature
% OCCURRENCE
100
75
50
25
Plant
Fish
Caddisfly larvae
Haliplids
Chironomid larvae
pupae
adults
Dytiscid larvae
adults
Corixids
Damselfly nymphs
adults
Dragonfly nymphs
Gammarus
Leeches

FIGURE 18
PERCENT OCCURRENCE
OF MAIN FOOD ITEMS
IN 42 ADULT AND 33
IMMATURE
PODICEPS AURITUS



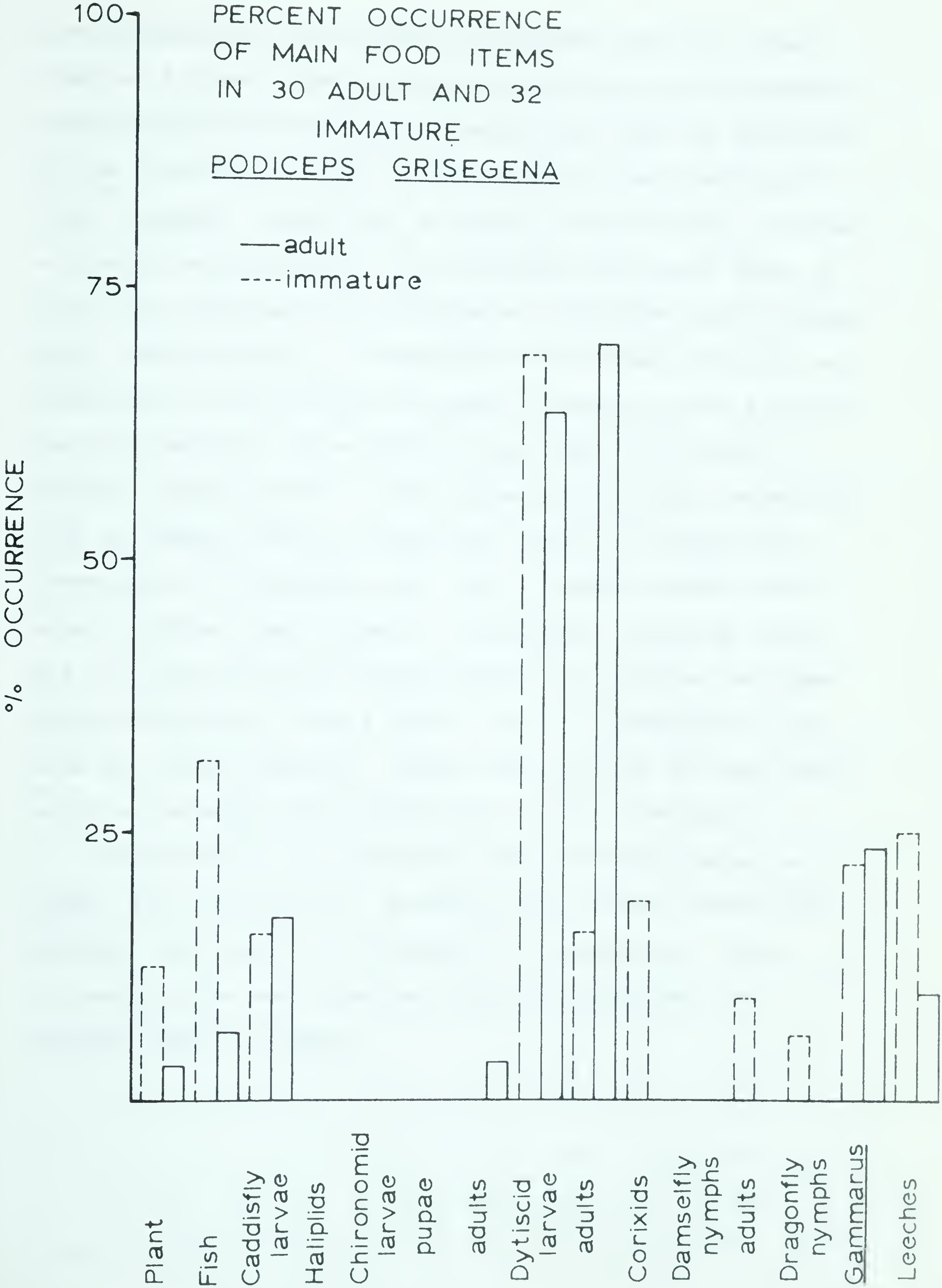


FIGURE 19
PERCENT OCCURRENCE OF MAIN FOOD ITEMS IN 30 ADULT AND 32 IMMATURE *PODICEPS GRISEGENA*

the ingestion of the infected intermediate host as a food item has a great effect on the helminth fauna of the grebes. Bychovskaya-Pavlovskaya (1962) points out that the diversity of the biohelminth fauna is determined by the diversity of foods ingested. Grebes eat a variety of food items and have a diverse helminth fauna. She concludes that each order of birds has characteristic families of trematodes which reflect their feeding habits. A comparison with other birds was not undertaken in this study but grebes do seem to have a characteristic helminth fauna which is associated with their aquatic feeding habits. She concluded that birds associated with an aquatic habitat become most heavily infected with trematodes. No attempts were made to compare grebes with other birds but they do have a substantial trematode fauna. She also concluded that birds feeding on a single food item characteristically have a large number of trematodes of the same or related species. Grebes eat a variety of food items so do not develop large populations of one trematode.

Differences in the helminth fauna of each species of grebe, with each habitat, probably with age and season are parallel with similar differences in food habits. Food is probably the most important factor influencing the helminth fauna of grebes.

SUMMARY

The helminth fauna of five species of grebes common to Alberta has been investigated. Forty-seven species of helminths (17 trematodes, 19 cestodes, 9 nematodes, 1 acanthocephalan, and 1 leech) were found in 348 birds examined. Many of these occurrences are new host (73) and North American (9) records. Seven of the cestodes found appear to be new species.

Sulgostowska's (1958) categorization of host-parasite relationships was expanded to include two new groups (accidental and inhibitory hosts). Twenty-eight relationships were placed in the main group, 78 in the auxiliary, eight in the accidental, and eight in the inhibitory.

Habitat differences on the breeding grounds was found to be an important factor determining the helminth fauna of grebes. Individuals (*Podiceps auritus*) collected from potholes, were found to have fewer species of helminths than grebes (*Podiceps grisegena* and *Aechmophorus occidentalis*) from lakes. Those from sloughs (*Podiceps caspicus* and *Podiceps grisegena*) had the most diverse helminth fauna.

Parasitism varied with season. Many patterns were seen in the seasonal infections of different helminths. A consideration of the seasonal variation of total intensity of infection revealed a drop in helminth numbers during the breeding period with subsequent peak later in the summer. This peak was greatest in *Podiceps caspicus* and least in *Podiceps auritus* because of differences in the habitat. There

is also an indication of a low intensity in the early spring and a decrease before the adult birds leave in the late summer. Immature birds showed a gradual increase in intensity of parasitism until a high level was maintained. A lack of data from the late fall made it impossible to say if this decreases before the birds leave.

It was found that contrary to findings of other workers young birds were not usually more heavily parasitized than adults. The most common grebe parasites were found to infect the young first. First acquisition of helminths is slower in *Podiceps auritus* on ponds than *Podiceps caspicus* and *P. grisegena* on sloughs.

Differences in the intensity and extensity of infection were correlated with differences in host species, habitat, season, and age, all of which appear to be mediated through food. Food is the most important factor governing the helminth fauna of grebes as most of their helminths are biohelminths.

LITERATURE CITED

Abdel-Malek, E. T. 1952. _Cercaria chandleri_, a new echinostome species from the snail _Helisoma corpulentum_ in Lake Itasca, Minn. Trans. Amer. Micr. Soc. 71:277-281.

__________________ 1953. Life History of _Petasiger chandleri_ (Trematoda, Echinostomatidae) from the Pied-billed Grebe, _Podilymbus podiceps_, with some comments on other species of _Petasiger_. J. Parasit. 39:152-157.

Addis, C. J. Jr. 1946. Experiments on the relation between sex hormones and the growth of tapeworms (_Hymenolepis diminuta_) in rats. J. Parasit. 32:574-580.

Angel, M. 1959. An account of _Plagiorchis maculosus_ (Rud.), its synonymy and its life history in South Australia. Trans. Roy. Soc. S. Aust. 82:265-281.

Baer, J. G. 1954. Revision taxinomique et étude biologique des cestodes de la famille des Tetrabothriidae, parasites d'oiseaux de haute mer et de mammiferes marinus. Mem. Univ. Neuchatel Sér. in-quarto. No. 1, 121 pages.

Baker, J. R. 1960. Cytological technique. John Wiley and Sons Inc., New York. 4th ed. 150 pages.

Baylis, H. A. 1944. Notes on some parasitic nematodes. Ann. Mag. Nat. Hist. 11:621-630.

Beaver, P. C. 1939a. The morphology and life history of _Petasiger nitidus_ Linton (Trematoda: Echinostomidae). J. Parasit. 25:269-276.

Beaver, P. C. 1939b. The morphology and life history of Psilostomum ondatrae Price, 1931. (Trematoda: Psilostomidae). J. Parasit. 25:383-393.

__________ 1941. The life history of Echinochasmus donaldsoni n.sp., a trematode (Echinostomidae) from the Pied-billed grebe. J. Parasit. 27:247-255.

Beck, J. W. 1952. Effect of gonadectomy and gonadal hormones on singly established Hymenolepis diminuta in rats. Exp. Parasit. 1:109-117.

Bennett, G. W. 1962. Management of artificial lakes and ponds. Reinhold Publ. Corp., New York. 283 pages.

Bent, A. C. 1919. Life histories of North American diving birds. U. S. Nat. Mus. Bull. 107:1-239.

Bezubik, B. 1956. Helminthofauna dzikich kaczek (podrodz. Anatinae). Acta Parasit. Polon. 4:407-510.

Bychovskaya-Pavlovskaya, I. E. 1962. (Trematodes of birds of the USSR). Russian text. Acad. Sci. USSR., Moscow and Leningrad. 408 pages.

Cable, R. M. 1951. An illustrated laboratory manual of parasitology. Burgess Publ. Co., Minneapolis, Minnesota. 152 pages.

Carrère, P. 1936. Sur le cycle évolutif d'un Maritrema (Trématodes). Compte Rendue Acad. Sci. Paris. 202:244-246.

Chandler, A. C. 1948. New species of the genus Schistotaenia with a key to known species. Trans. Amer. Micro. Soc. 67:169-176.

Cheatum, E. L. 1941. _Dendritobilharzia anatinarum_ n.sp., a blood fluke from the Mallard. J. Parasit. 27:165-170.

Clerc, W. 1907. Note sur les cestodes d'oiseaux de l'Oural. 3. Quelques observations sur _Diococestus aspera_ Fuhrmann et sur les organes genitaux de _Schistotaenia macrorhyncha_ Rud. Centralbl. Bakteriol., 1. Abt. 43:703-708.

Coil, W. H. 1955. Notes on the genus _Maritrema_ Nicoll, 1907, (Trematoda: Microphallidae) with the description of two new species. J. Parasit. 41:533-537.

Connell, R. and A. H. Corner. 1957. _Polymorphus paradoxus_ sp. nov. (Acenthocephala) parasitizing beavers and muskrats in Alberta, Canada. Canadian J. Zool. 35:525-533.

Cornwell, G. W. and A. B. Cowan. 1963. Helminth populations of the Canvasback (_Aythya valisineria_) and host-parasite-environmental interrelationships. Trans. 28th N. Amer. Wildl. and Nat. Res. Conf.:173-198.

Cram. E. B. 1927. Bird parasites of the nematode Suborders Strongylata, Ascaridata, and Spirurata. U. S. Nat. Mus. Bull. 140:465 pages.

Dubois, G. 1938. Monographie des Strigeida. Soc. Neuchatel. des Sci. Nat. 6:535 pages.

__________ 1951. Etude des trématodes Nord-Americains de la collection E. L. Schiller et revision du genre _Notocotylus_ (Diesing, 1839). Bull. Soc. Neuchatel. Sci. Nat. 74:41-76.

__________ 1953. Systematique des Strigeida Complément de la monographie. Soc. Neuchatel. des Sci. Nat. 8:141 pages.

Etges, F. J. 1953. Studies on the life histories of *Maritrema obstipum* (Van Cleave and Mueller, 1932) and *Levinseniella amnicolae* n.sp. (Trematoda: Microphallidae). J. Parasit. 39:643-662.

Fuhrmann, O. 1900. Zur kenntnis der Acoleinae. Zentr. für Bakt. u. Parasit. 28:363-376.

____________ 1904a. Ein merkwurdiger getrenntgeschlechtliger cestode. Zool. Anz. 27:327-331.

____________ 1904b. Ein getrenntgeschlechtiger cestode. Zool. Jahrb. Abt. Syst. 20:131-146.

Hughes, R. C. 1941. A key to the species of tapeworms in *Hymenolepis*. Trans. Amer. Micr. Soc. 60:378-414.

Hunter, W. S. and W. B. Vernberg. 1953. *Pseudospelotrema ammospizae* sp. now., (Trematoda: Microphallidae) from the Seaside sparrow *Ammospiza maritima macgillivraii* (Audubon). J. Parasit. 39:84-87.

Jarecka, L. 1960. Separation of sexes and quantitative regulation in cestodes of the genus *Diploposthe* Jacobi, 1896 (Cestoda-Diploposthidae) Bull. de l'Acad. Polon. des Sci. 8:155-157.

Johnston, T. H. and L. M. Angel. 1941. Life history of the trematode, *Petasiger australis* n.sp. Trans. Roy. Soc. S. Aust. 65:285-291.

Joyeux, C. and J. G. Baer. 1950. Sur quelques espèces nouvelles ou peu connues du genre *Hymenolepis* Weinland, 1858. Bull. Soc. Neuchatel. Sci. Nat. 73:51-70.

Korpaczewska, W. 1960. Some reflections on *Hymenolepis*

furcifera Krabbe, 1869 and related species. Acta Parasit. Polon. 8:461-470.

Kozicka, J. and K. Niewiadomska. 1960. Tylodelphys podicipina sp. n. (Trematoda, Strigeidae) and its life cycle. Acta Parasit. Polon. 8:25-36.

Lapage, G. 1956. Monnig's veterinary helminthology and entomology. Bailliere, Tindall and Cox., London. 4th ed. 511 pages.

LaRue, G. R. 1957. The classification of Digenetic Trematoda: a review and a new system. Exp. Parasit. 6:306-349.

Lawrence, G. E. 1950. The diving and feeding activity of the Western grebe on the breeding grounds. Condor 52:3-16.

Lees, E. and L. Bass. 1960. Sex hormones as a possible factor influencing the level of parasitization in frogs. Nature 188:1207-1208.

Linton, E. 1925. A new diecian cestode. J. Parasit. 11:163-169.

__________ 1927. Notes on cestode parasites of birds. Proc. U.S. Nat. Mus. No. 2656. 70:1-73.

__________ 1928. Notes on trematode parasites of birds. Proc. U.S. Nat. Mus. No. 2722. 73:1-36.

Lopez-Neyra, C. R. 1947. Los Capillarinae. Mem. de la Real Acad. de Ciencias de Madrid. Serie de Ciencias Nat. 12:1-248.

McAllister, N. M. 1963. Ontogeny of behavior in five species of grebes. Unpublished Ph.D. thesis, University

of British Columbia. 135 pages.

Mahon, J. 1956. On a collection of avian cestodes from Canada. Canadian J. Zool. 34:104-119.

Mawson, P. M. 1956. Ascarid nematodes from Canadian birds. Canadian J. Zool. 34:35-47.

Mettrick, D. F. 1963. A revision of the genus Ribeiroia Travassos, 1939 with some observations on the family Cathaemasiidae Fuhrmann, 1928 including the erection of a new sub-family Reeselliinae. Rev. Zool. Bot. Afr. 67:137-162.

Michajłow, W. 1959. Resistance of hosts and endoparasites; parasitological groups of hosts and types of systems "host-parasite". Acta Parasit. Polon. 7:467-487.

Odening, K. 1962. Trematoden aus einheimischen Vogeln des Berliner tierparks und der umgebung von Berlin. Biol. Zentr. 4:419-468.

Olsen, O. W. 1937. A systematic study of the trematode subfamily Plagiorchiinae Pratt, 1902. Trans. Amer. Micr. Soc. 56:311-339.

Rao, K. N. S. 1951. Cosmocephalus firlottei n. sp., (Family Acuariidae) from the Seagull (Larus argentatus). Canadian J. Zool. 29:173-177.

Read, C. P. 1949. Studies on North American helminths of the genus Capillaria. Zeder, 1800 (Nematoda): II. Additional capillarids from mammals with keys to the North American mammalian species. J. Parasit. 35:231-239.

Rothschild, M. and T. Clay. 1952. Fleas, flukes and cuckoos. Collins, London. 304 pages.

Schell, S. C. 1955. Schistotaenia colymba n. sp. from the Horned grebe (Colymbus auritus L.) Trans. Amer. Micr. Soc. 74:346-350.

Schultz, R. L. 1940. Some observations on the Amabiliid cestode, Tatria duodecacentha. Olsen, 1939. J. Parasit. 26:101-103.

Skrjabin, K. I., et al. 1964. Keys to the trematodes of animals and man. Univ. Illinois Press, Urbana: 351 pages. English translation edited by H. P. Arai, translated by R. W. Dooley.

Storer, R. W. 1961. Observations of pellet-casting by Horned and Pied-billed grebes. Auk 78:90-92.

Sulgostowska, T. 1958. Flukes of birds of Druzno Lake. (Parasitofauna of the biocoenosis of Druzno lake- Part III). Acta Parasit. Polon. 3:111-142.

_______________ 1963. Trematodes of birds in the biocoenosis of the lakes Druzno, Gołdapiwo, Mamry Połnocne and Swiecajty. Acta Parasit. Polon. 11:239-264.

Szymanski, M. 1905. Ein beitrag zur helminthologie (polonais). Bull. Acad. Sci. Cracovie:733-735.

Thomas, R. C. [1959] Alberta Lake Fisheries. Alberta Dept. of Lands and Forests. 18 pages.

Tseng Shen. 1932. Etude sur les cestodes d'oiseaux de Chine. Ann. Parasit. Hum. Comp. 10:105-128.

Voge, M. and C. P. Read. 1954. A description of

Parafimbriaria websteri n.g., n.sp., a cestode from grebes, and notes on three species of Hymenolepis. J. Parasit. 40:564-570.

Wardle, R. A. and J. A. McLeod. 1952. The zoology of tapeworms. Univ. Minnesota Press, Minneapolis. 780 pages.

Welch, P. S. 1952. Limnology. McGraw-Hill Book. Co. Inc., New York, Toronto and London. 2nd ed.:538 pages.

Wetmore, A. 1924. Food and economic relations of North American grebes. U.S. Dept. Agr. Bull. 1196. 24 pages.

Yamaguti, S. 1941. Studies on the helminth fauna of Japan. Pt. 36. Avian nematodes, II. Jap. J. Zool. 9:441-480.

____________ 1958. Systema helminthum. Vol. I. The digenetic trematodes of vertebrates. Interscience Publ., New York and London. 1575 pages.

____________ 1959. Systema helminthum. Vol. II. Cestodes. Interscience Publ., New York and London. 859 pages.

____________ 1961. Systema helminthum. Vol. III. Nematodes. Interscience Publ., New York and London. 1261 pages.

____________ 1963. Systema helminthum. Vol. V. Acanthocephala. Interscience Publ., New York and London. 423 pages.

EXPLANATION OF PLATES

Plate 1

Lateriporus sp. ex Podiceps grisegena.

Fig. 1 scolex
Fig. 2 cirri

Plate 2

Lateriporus sp. (immature) ex Podiceps grisegena.

Fig. 3 scolex
Fig. 4 scolex
Fig. 5 hook

Plate 3

Dicranotaenia sp. ex Aechmophorus occidentalis.

Fig. 6 scolex
Fig. 7 hook
Fig. 8 mature proglottids in area of maximum testes development.

Plate 4

Dicranotaenia sp. ex Aechmophorus occidentalis.

Fig. 9 mature proglottids in area of maximum ovarian development.
Fig. 10 degenerate gravid proglottids.

Plate 5

Dubininolepis furcifera ex Podiceps caspicus.

Fig. 11 scolex
Fig. 12 hook

Dubininolepis podicipina ex Podiceps caspicus.

Fig. 13 scolex
Fig. 14a hook, oblique view
b hook, lateral view
c hook, end view

Plate 6

Hymenosphenacanthus sp. 1 ex Podiceps caspicus.

Fig. 15 scolex

Fig. 16 hook

<u>Diorchis</u> sp. ex <u>Podiceps caspicus</u>

Fig. 17 scolex
Fig. 18 hook

Plate 7

<u>Hymenosphenacanthus</u> sp. 2 ex. <u>Podiceps grisegena</u>.

Fig. 19 scolex
Fig. 20 hook
Fig. 21 mature proglottid
Fig. 22 hooklets on proglottid.

Plate 8

<u>Nadejdolepis</u> sp. ex <u>Podiceps grisegena</u>.

Fig. 23 scolex
Fig. 24 hook
Fig. 25 gravid proglottid
Fig. 26 mature proglottid

Plate 9

<u>Schistotaenia colymba</u> ex <u>Podiceps caspicus</u>.

Fig. 27 scolex
Fig. 28 hook

<u>Schistotaenia tenuicirrus</u> ex <u>Podilymbus podiceps</u>.

Fig. 29 scolex
Fig. 30 hook

Plate 10

<u>Schistotaenia</u> sp. ex <u>Podiceps grisegena</u>.

Fig. 31 scolex
Fig. 32 hook
Fig. 33 mature proglottids

Plate 11

<u>Schistotaenia</u> sp. ex <u>Podiceps grisegena</u>.

Fig. 34 gravid proglottid
Fig. 35 strobila

Plate 12

Tatria biremis ex *Podiceps auritus*.

Fig. 36 scolex
Fig. 37 hook

Tatria decacantha ex *Podiceps caspicus*.

Fig. 38 scolex
Fig. 39 hook

Plate 13

Dioecocestus sp. (immature) ex *Podiceps grisegena*.

Fig. 40 scolex

Plate 14

Capillaria michiganensis ex *Podiceps caspicus*.

Fig. 41 male, posterior end of body
Fig. 42 male, proximal end of spicule
Fig. 43 egg

acc. sac	accessory sac
c.p.	cirrus pouch
cir.	cirrus
ex. v.	excretory vessel
e.s.v.	external seminal vesicle
i.s.v.	internal seminal vesicle
ov.	ovary
s.r.	seminal receptacle
s.v.	seminal vesicle
t.	testis
ut.	uterus
vit.	vitellaria

PLATE 1

LATERIPORUS

SP.

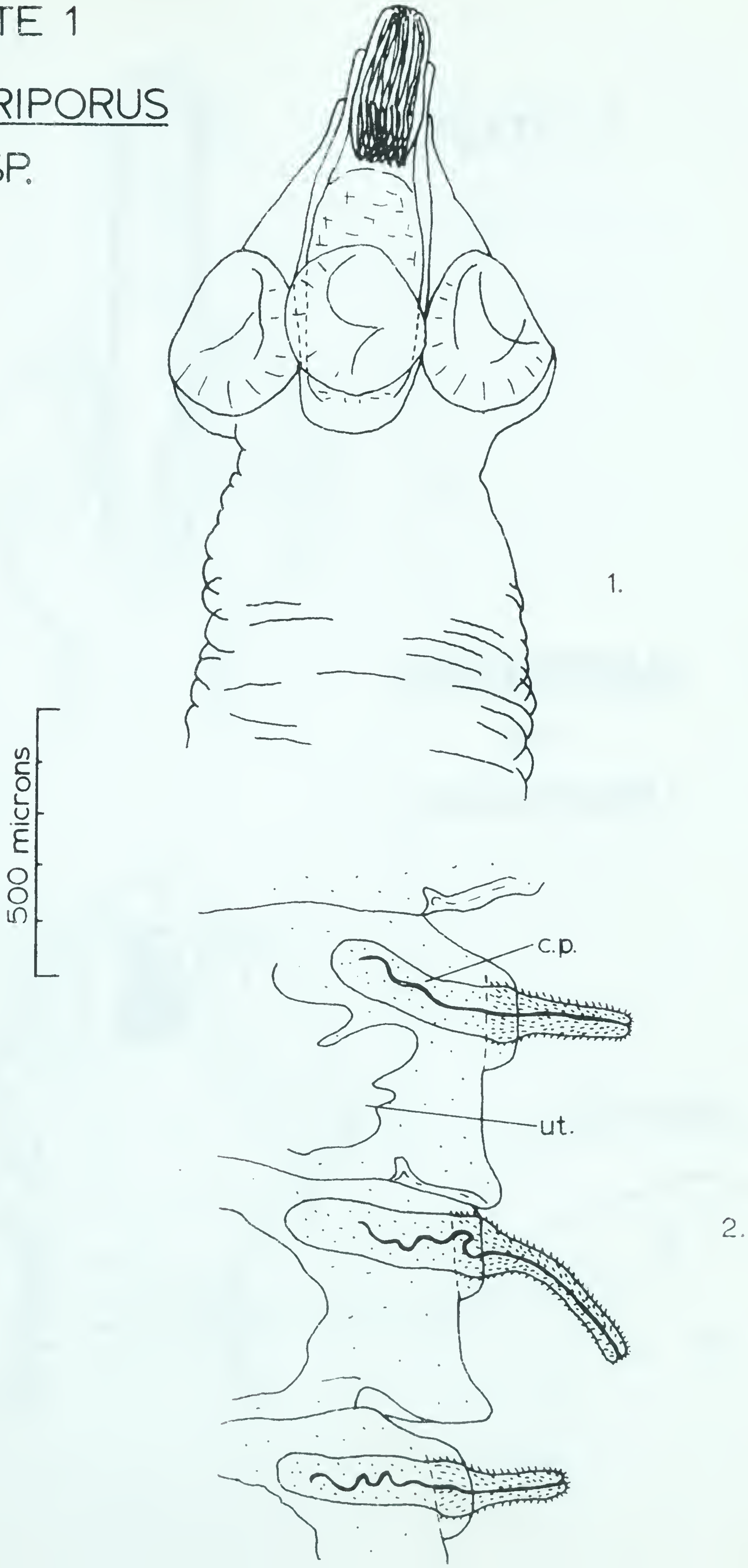
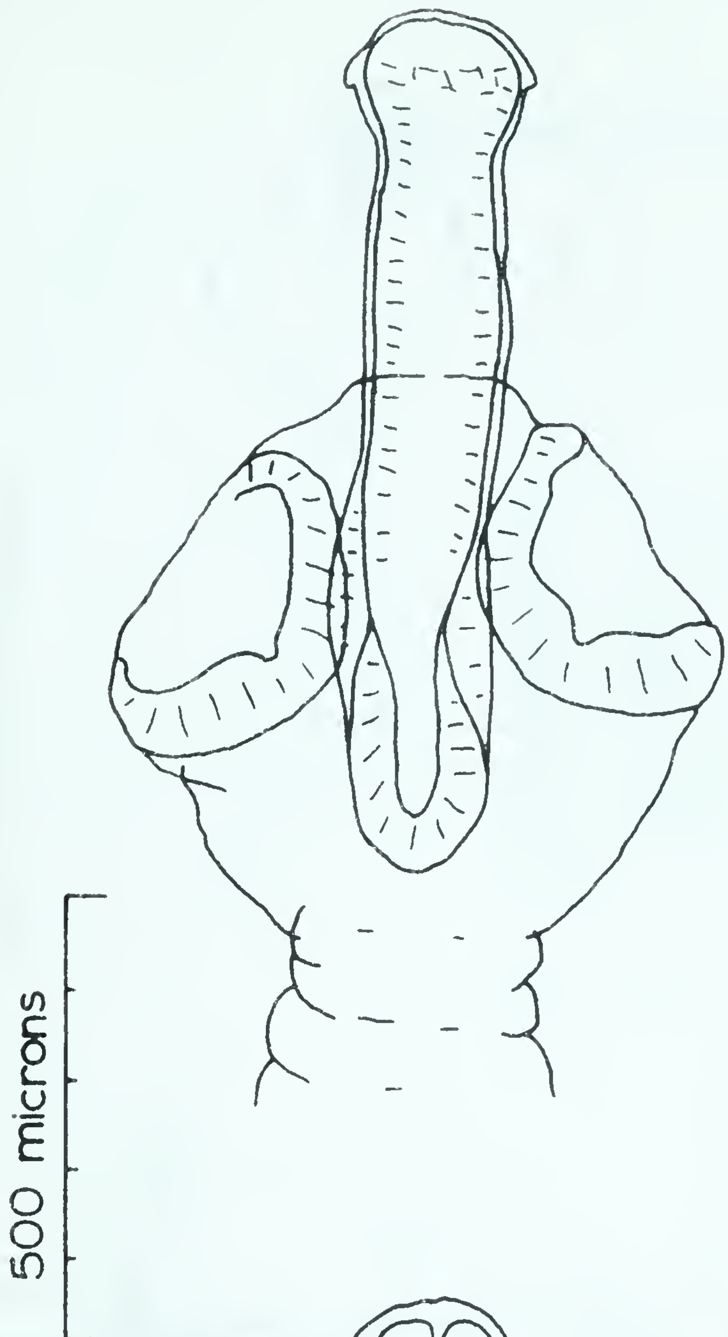
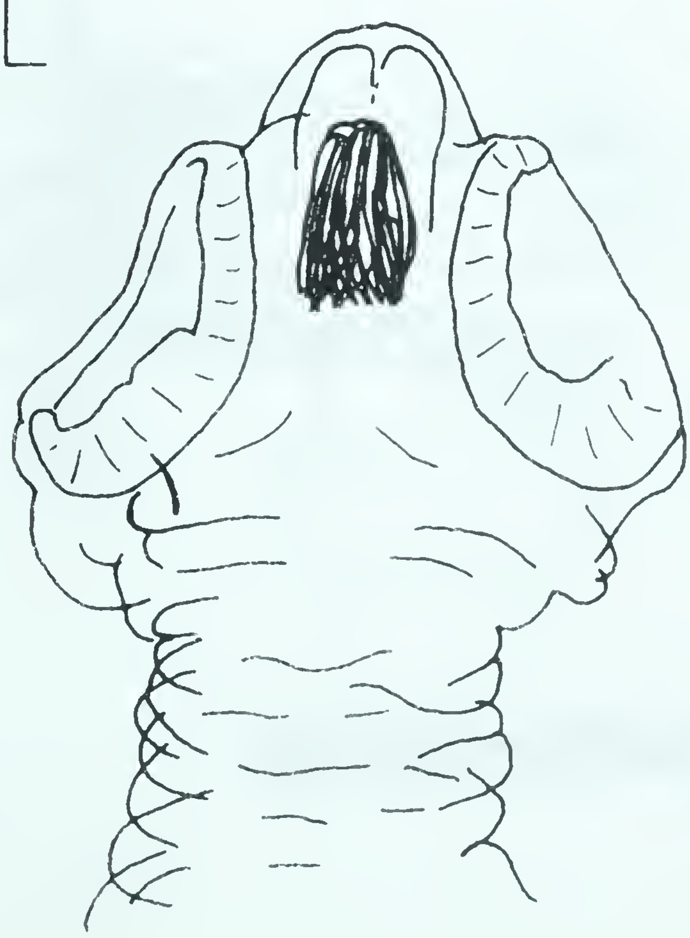


PLATE 2

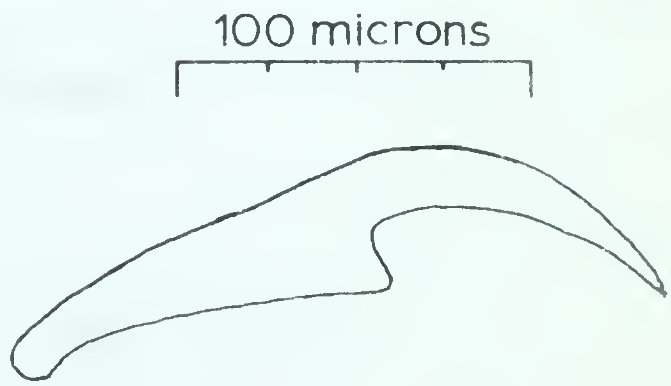


3.

LATERIPORUS
SP.
(IMMATURE)

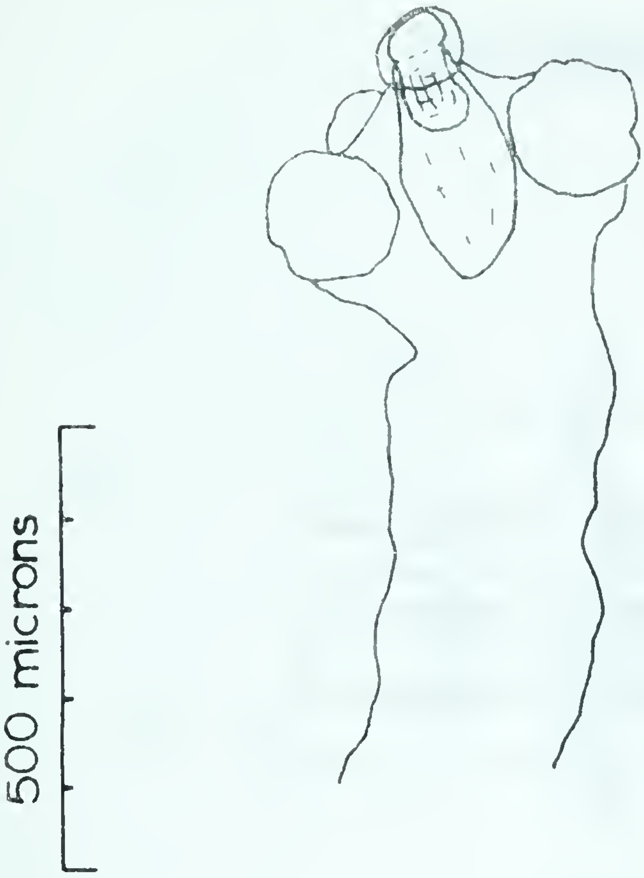


4.

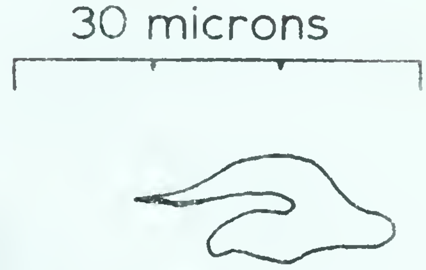


5.

PLATE 3

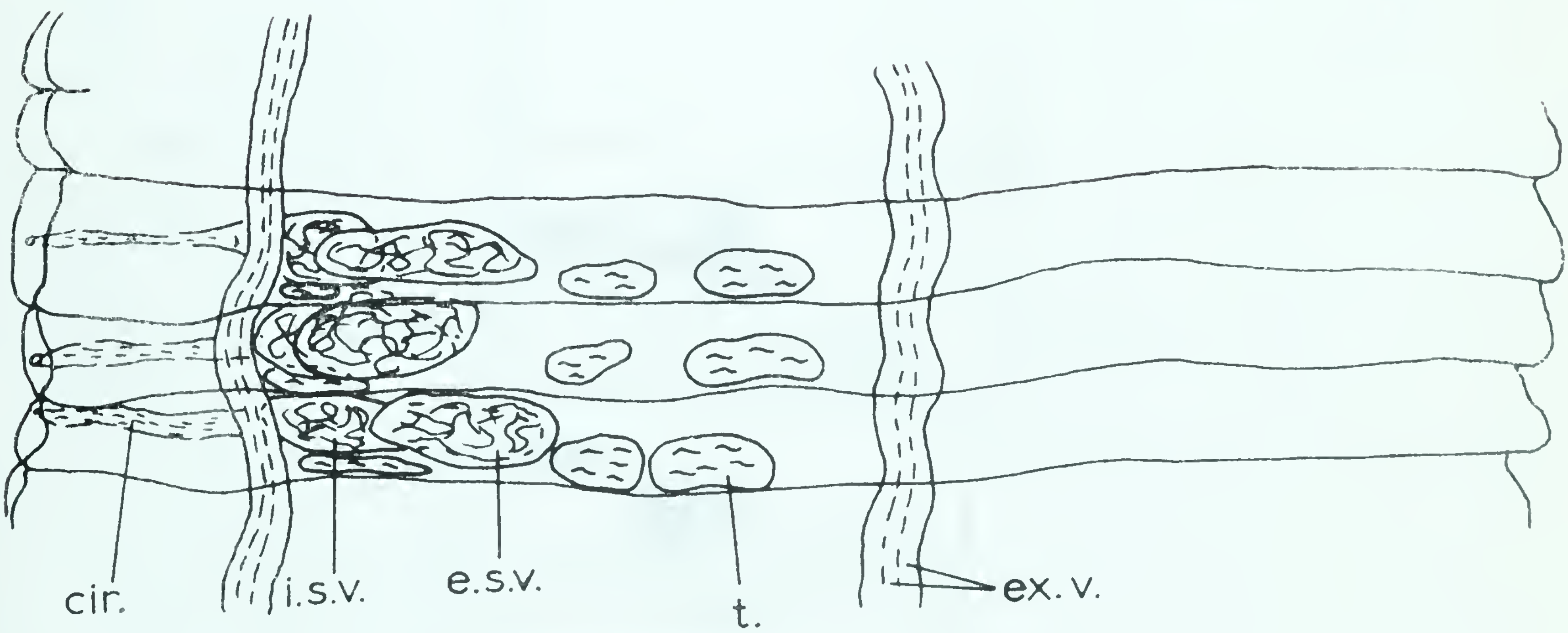


6.



7.

8.



DICRANOTAENIA SP.

PLATE 4

DICRANOTAENIA SP.

9.

10.

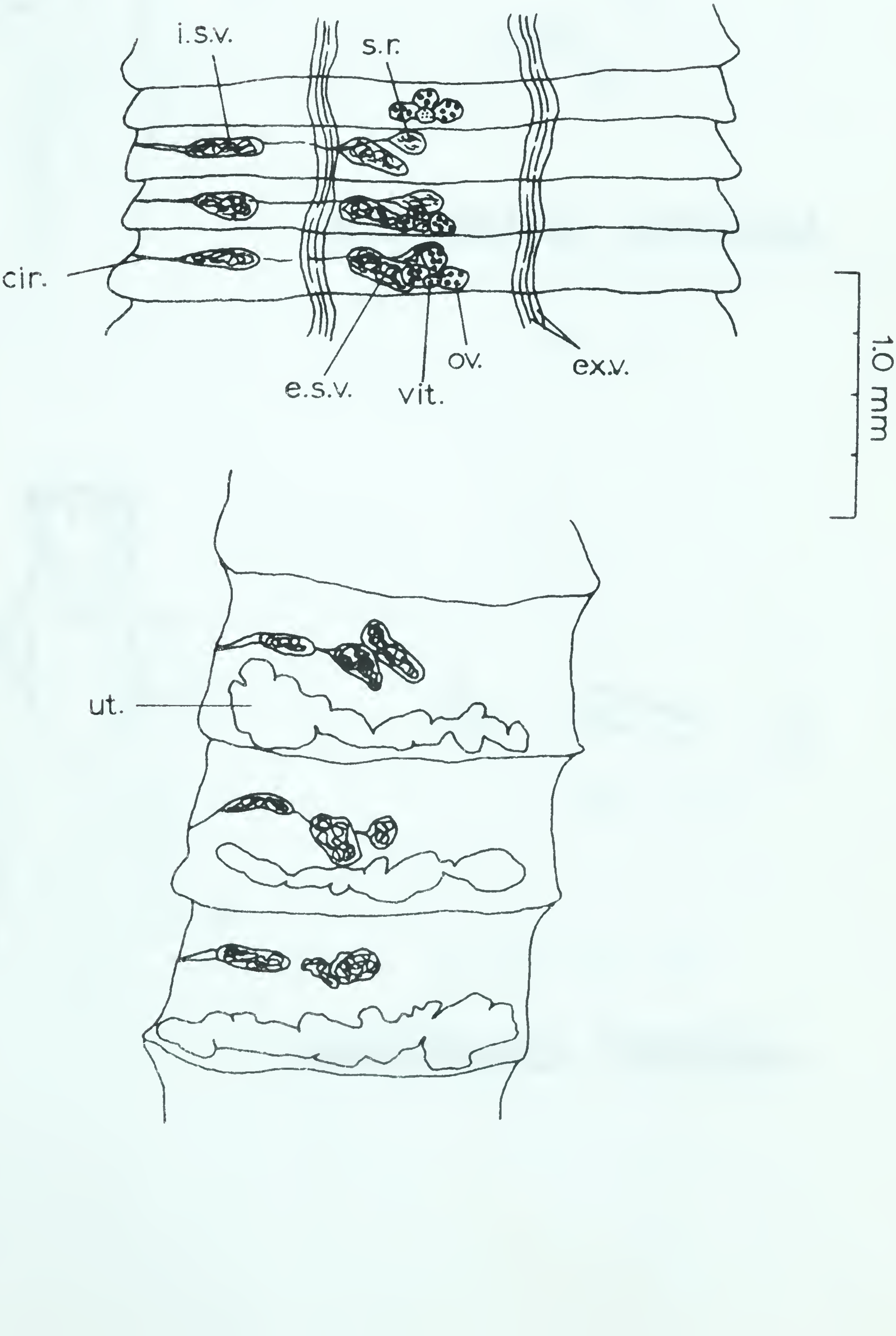
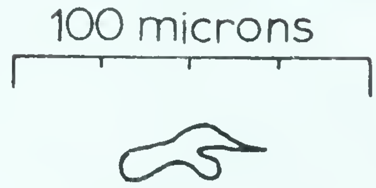
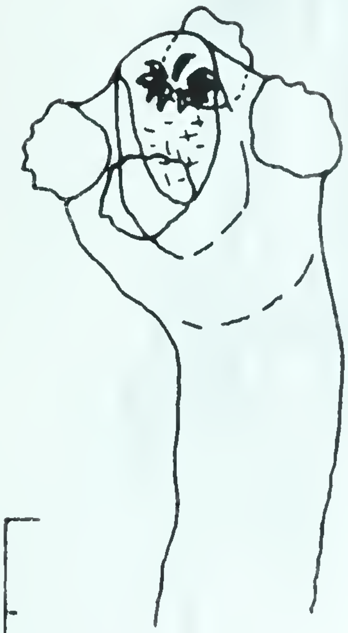


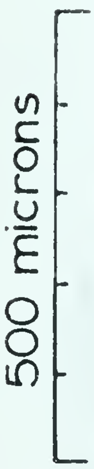
PLATE 5



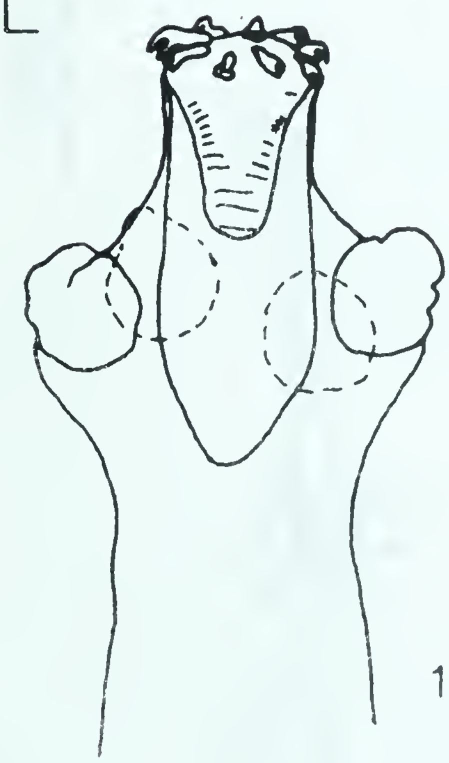
12.



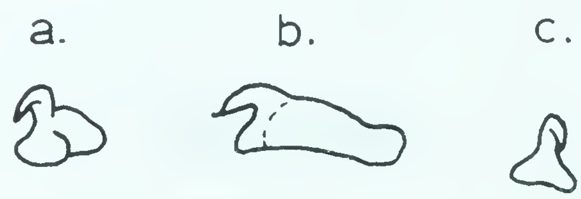
11.



DUBININOLEPIS FURCIFERA



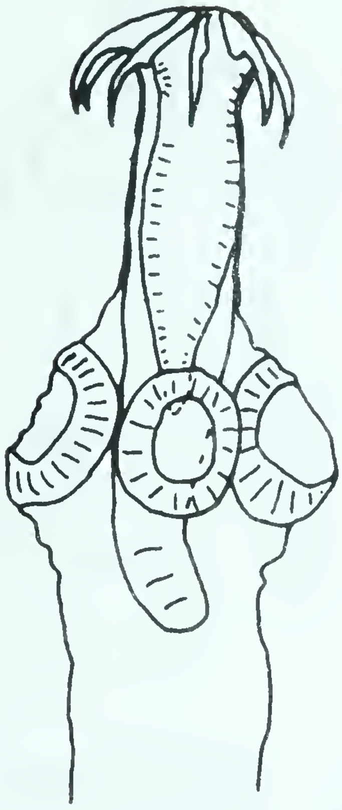
13.



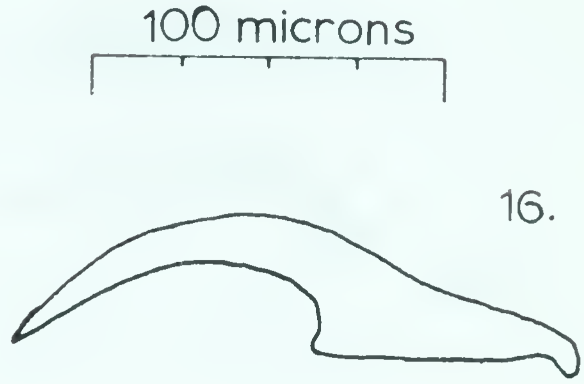
14.

DUBININOLEPIS PODICIPINA

PLATE 6



15.

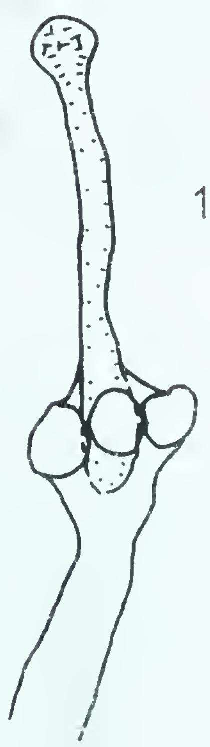


16.

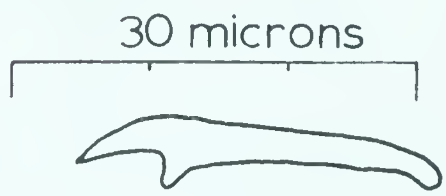
<u>HYMENOSPHENACANTHUS</u>

SP. NO.1

500 microns



17.

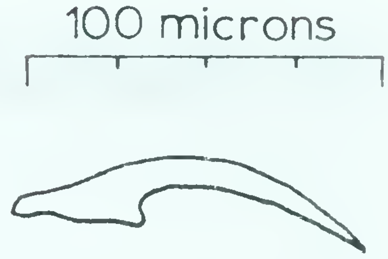


18.

<u>DIORCHIS</u> SP.

PLATE 7

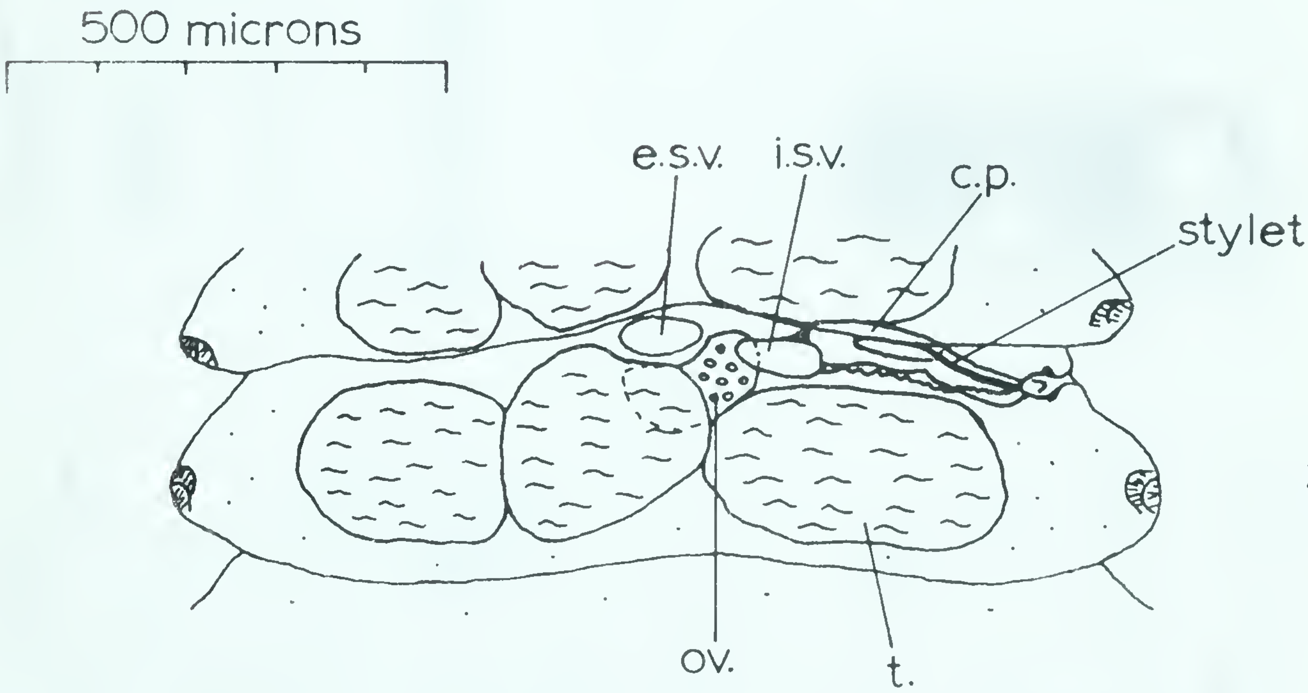
19.



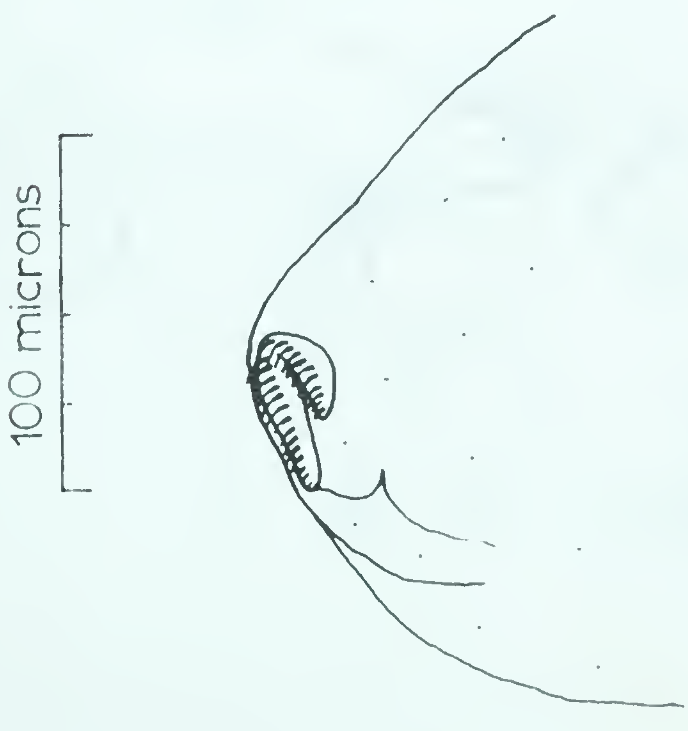
20.

HYMENOSPHENACANTHUS

SP. NO. 2



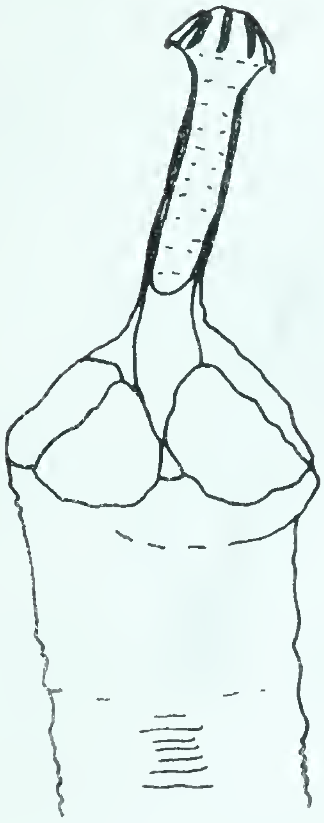
21.



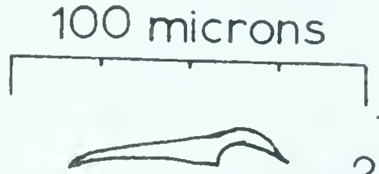
22.

PLATE 8

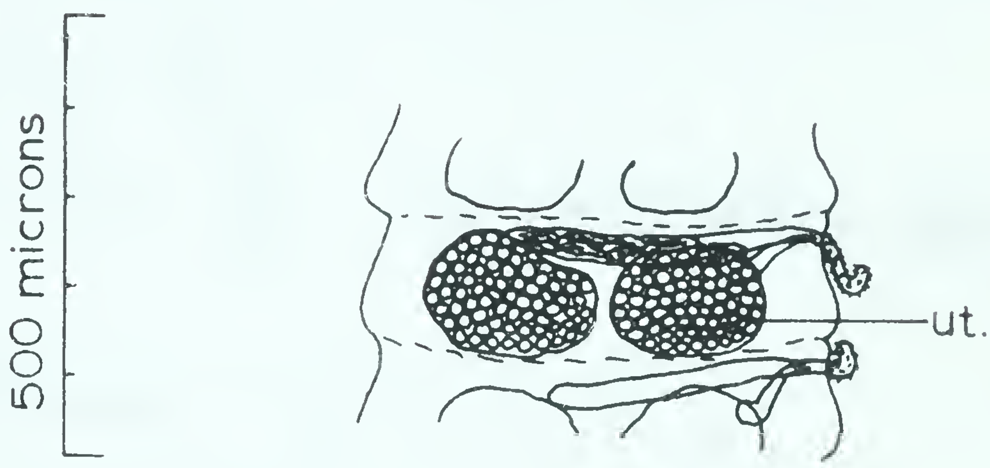
NADEJDOLEPIS SP.



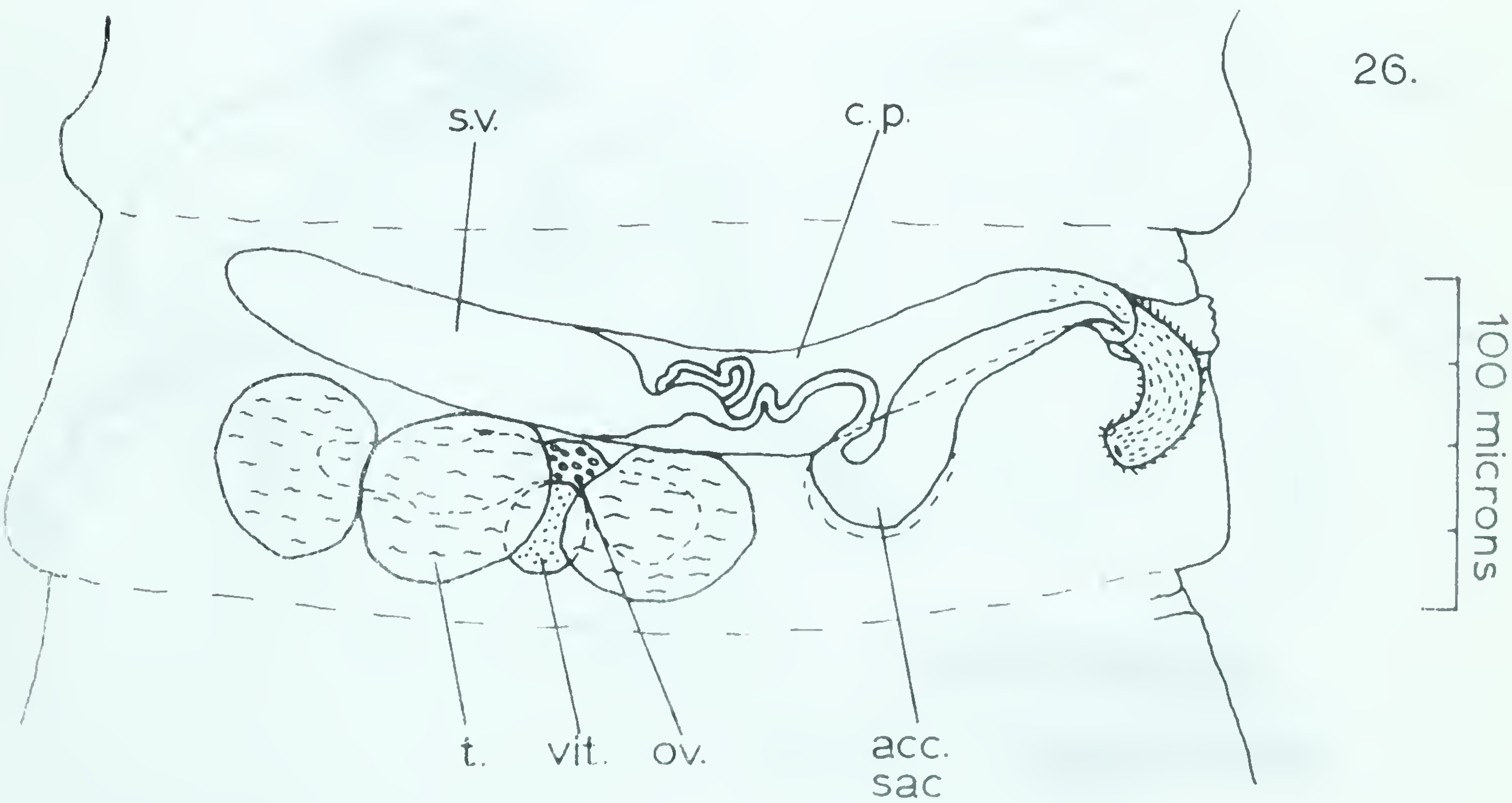
23.



24.



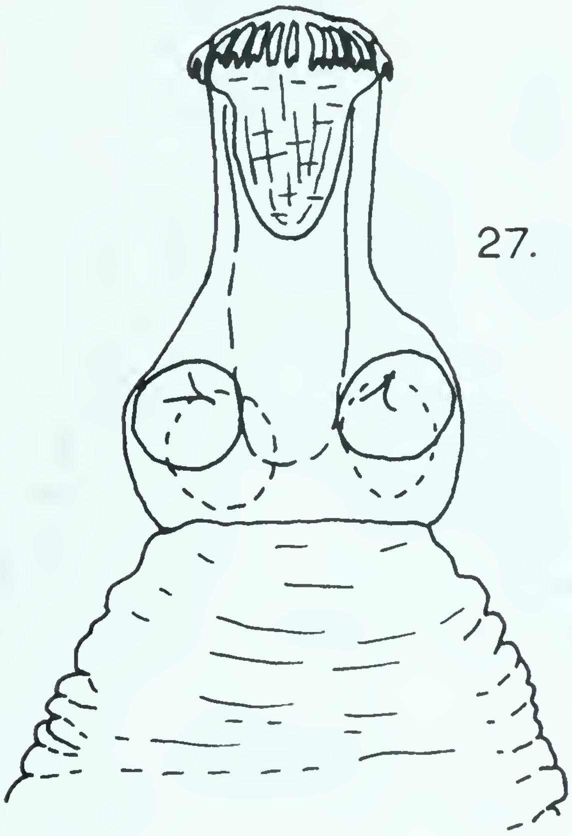
25.



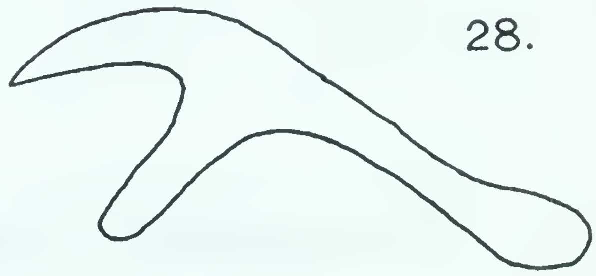
26.

PLATE 9

100 microns



27.

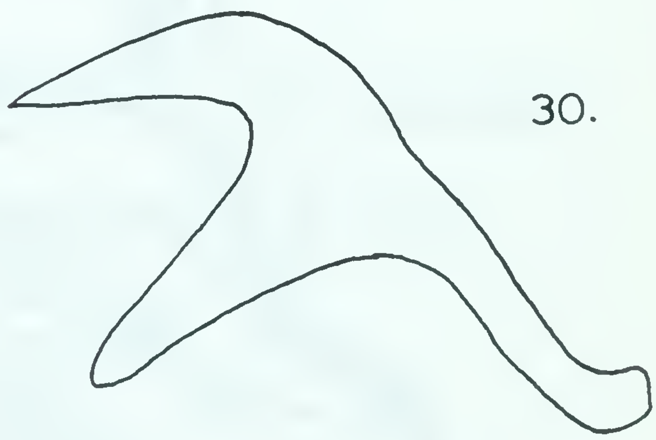


28.

SCHISTOTAENIA COLYMBA

1 mm.

29.

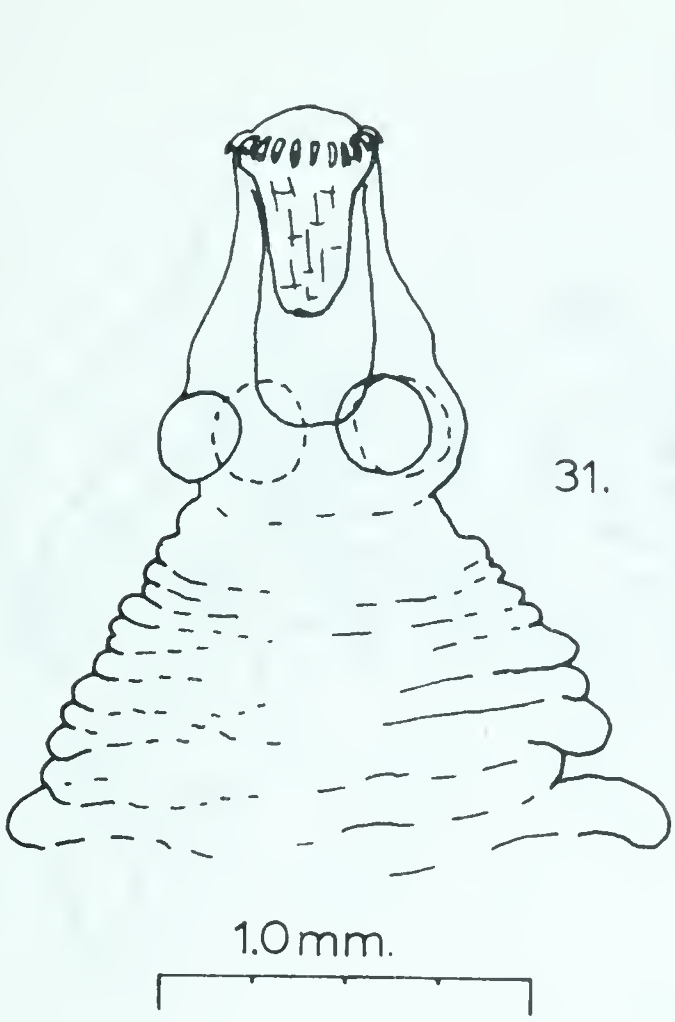


30.

SCHISTOTAENIA

TENUICIRRUS

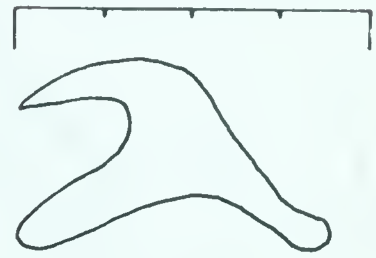
PLATE 10



31.

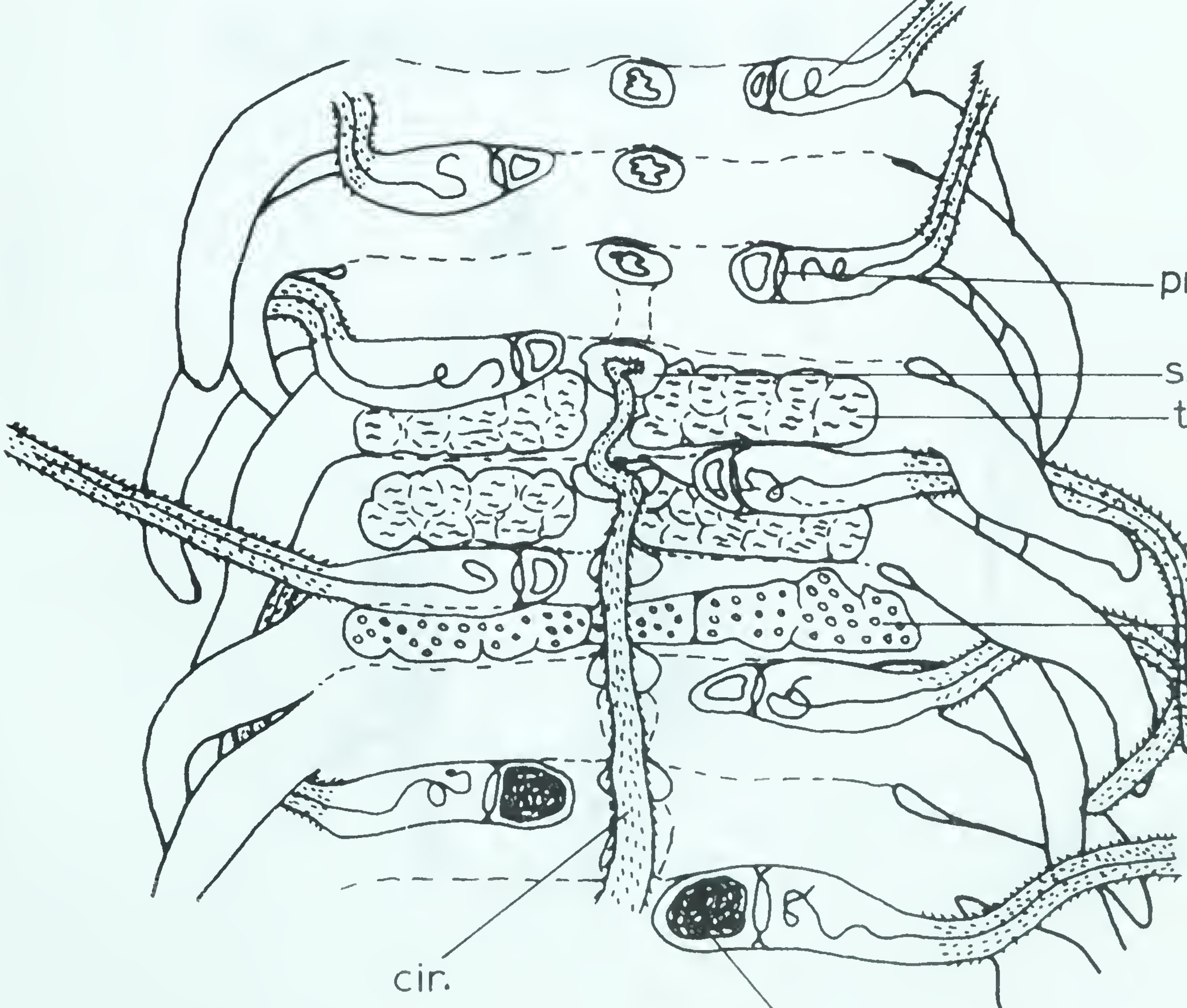
1.0 mm.

100 microns



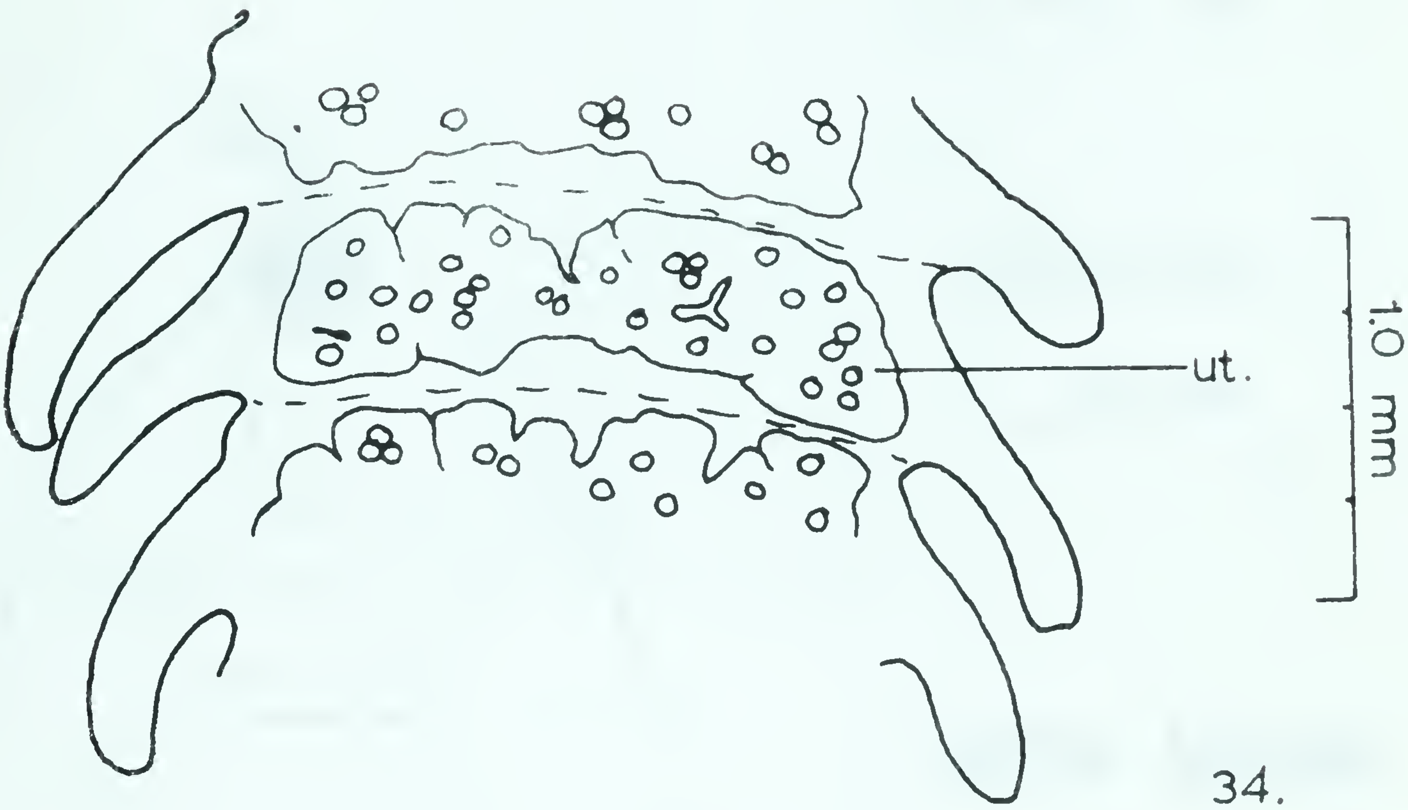
32.

SCHISTOTAENIA SP.



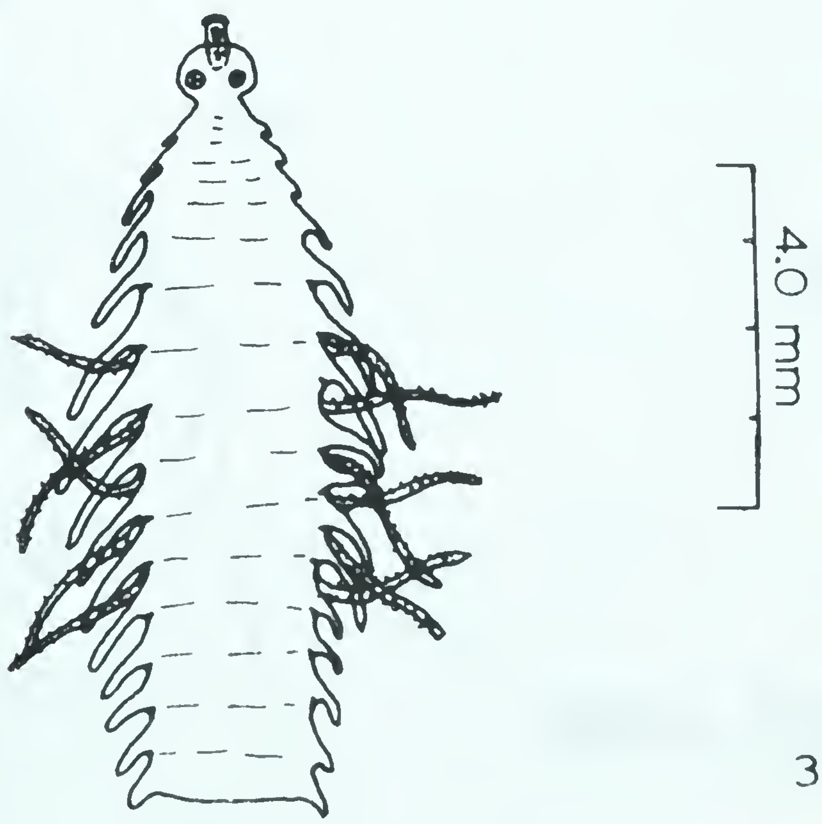
33.

PLATE 11



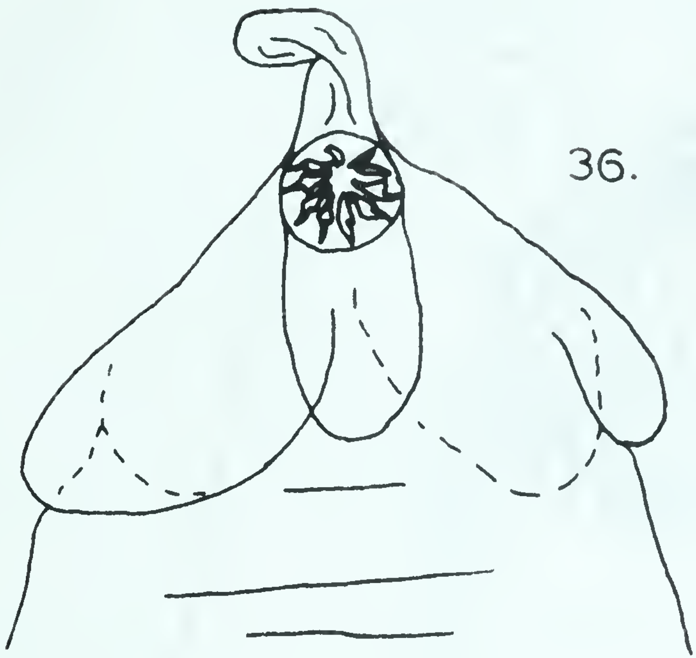
34.

SCHISTOTAENIA SP.

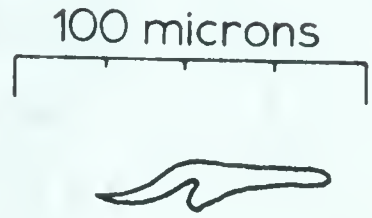


35.

PLATE 12

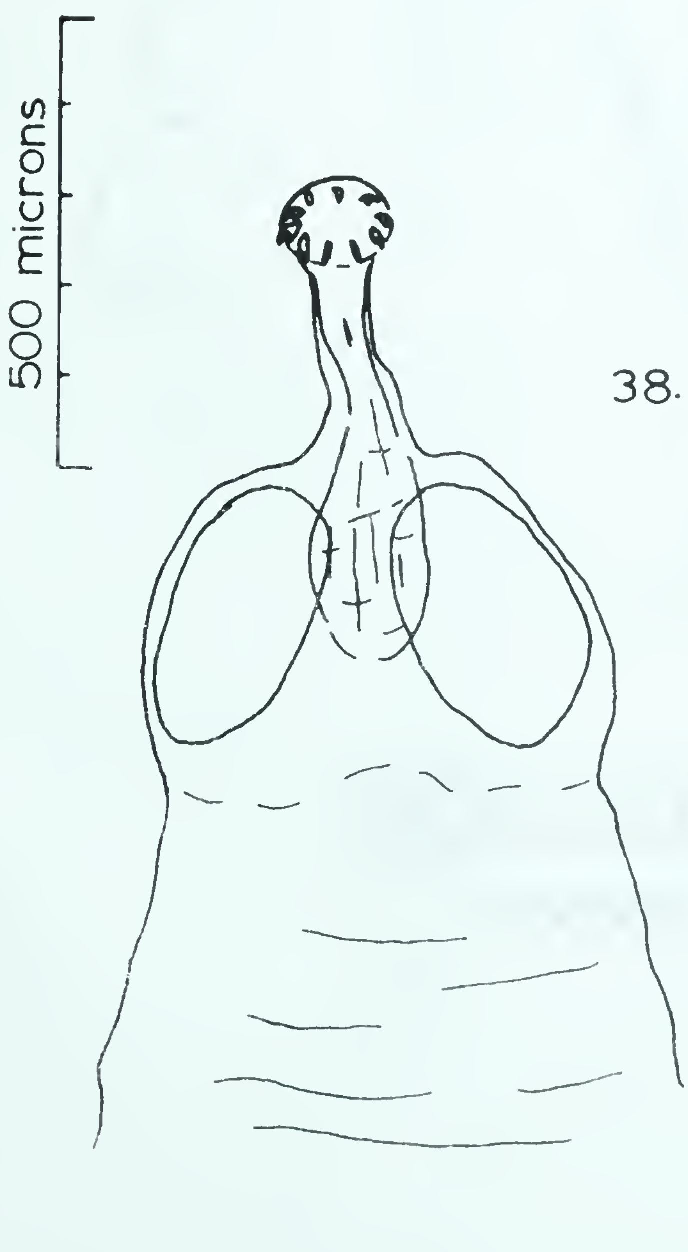


36.



37.

<u>TATRIA</u> <u>BIREMIS</u>

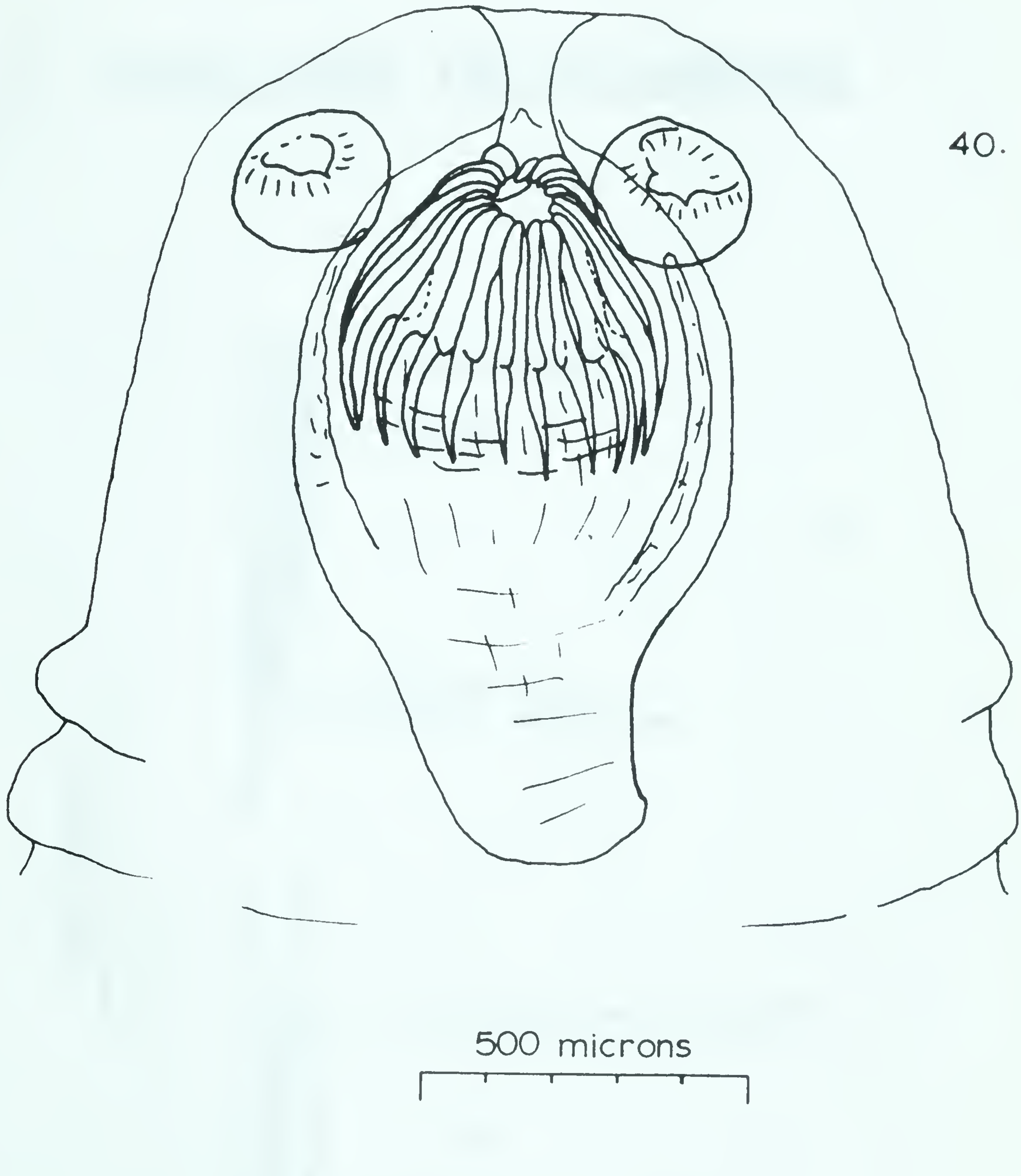


38.

39.

<u>TATRIA</u> <u>DECACANTHA</u>

PLATE 13



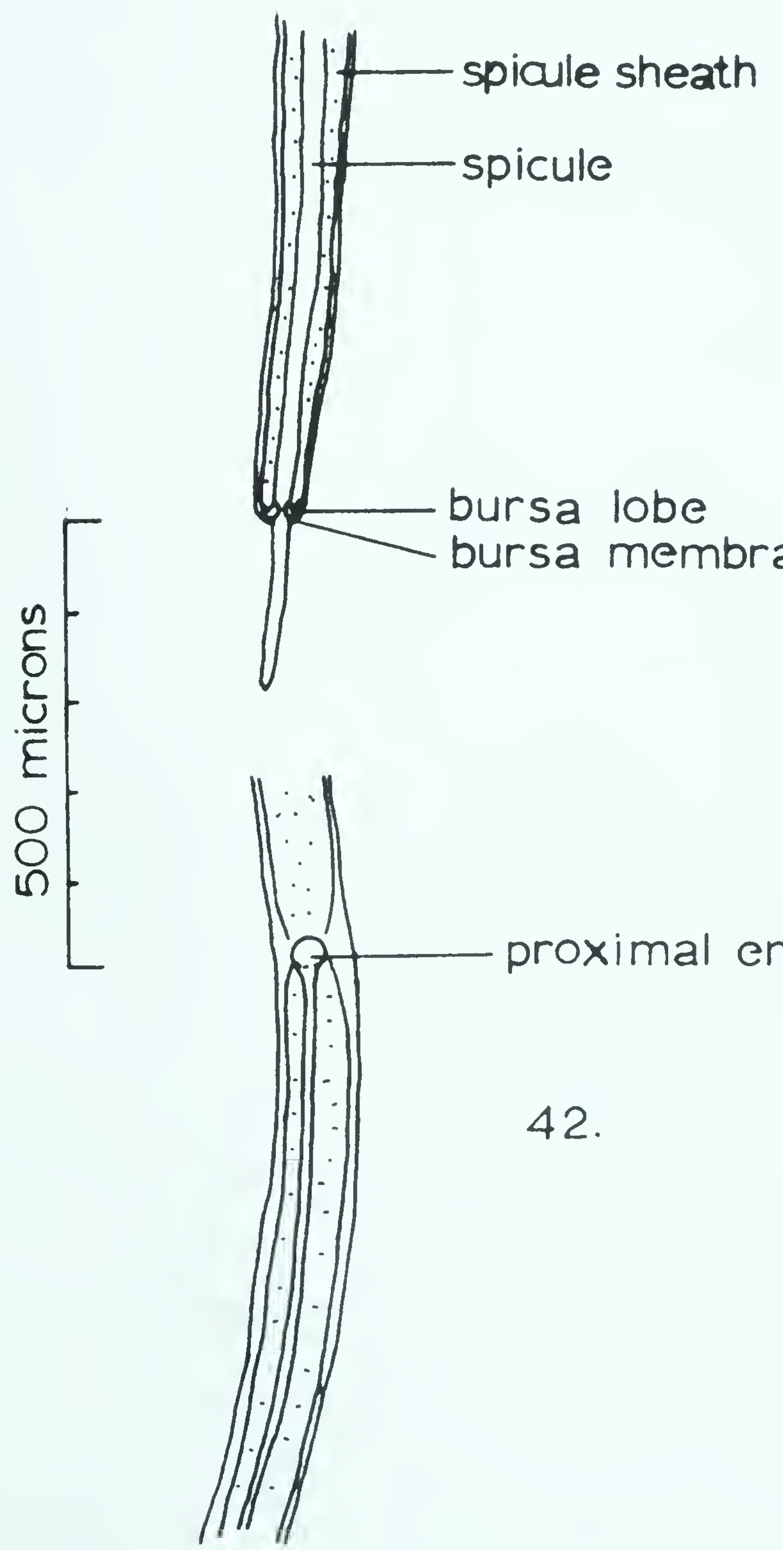
40.

500 microns

DIOECOCESTUS SP.
(IMMATURE)

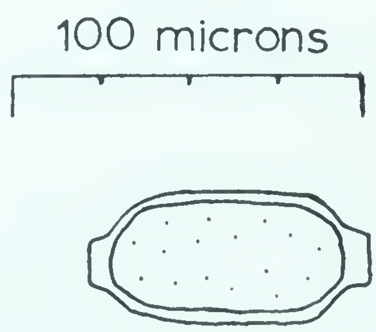
PLATE 14

<u>CAPILLARIA MICHIGANENSIS</u>



41.

42.



43.